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ART. XXXIV.—*On the relations of the Geology of Vermont to that of Berkshire;* by JAMES D. DANA.

[Continued from page 207.]

2. LITHOLOGICAL CONCLUSIONS: WITH SPECIAL REFERENCE TO THE USE OF LITHOLOGICAL CHARACTERS AS A TEST OF GEOLOGICAL AGE.

IT is sometimes laid down as a canon in geology that the age of a crystalline terrane or formation can be told from the kind of rock constituting it. Thorough knowledge as to the kinds that may exist in formations of the same age is the proper basis for such a canon—if it has a basis—and a test of its value. The limestone series affords important facts on this subject.

The Taconic slate-belt in the western half of the limestone area and the quartzyte group of the eastern half may be separately considered, and, afterward, the relations of the two.

1. *Taconic slate-belt or range.*

The diversity of rocks in the Taconic slate-belt is small compared with that in the Eastern or Quartzyte group.

A. *In Vermont.*—The rocks, as has been explained, are (1) *argillyte* to the north; then argillyte along the center with borders of (2) *hydromica slate* varying from a pure slaty hydrous mica to a mixture of hydrous mica with more or less quartz; (3) *chloritic hydromica slate*, in which quartz seams and veins (often chloritic) are common. Besides these, there is (4) a *hydromicaceous conglomerate*, consisting of quartz pebbles in a

hydromica paste, "abundant in Ira, Middletown, Wells, Poultney and Pawlet," and the main constituent of Bird Mountain, in Ira—as stated in the Vermont Geological Report (p. 426).

B. *In Berkshire and farther south.*—There are here the same slates, but in part coarser. Also (5), a rock of gneissoid aspect, in which the mica is a pearly hydrous mica (found in the Graylock range, near Williamstown); (6) a *garnetiferous chloritic hydromica slate*, common; (7) *mica schist;* (8) *graphitic mica schist;* (9) *garnetiferous mica schist;* and (10) *staurolitic mica schist* (in Salisbury and Sharon.)*

2. *Schists of the Quartzyte group.*

A. *In Vermont.*—(1) *Hydromica slate*, which is often very fine in grain and is then called *novaculite slate;* (2) *chloritic hydromica slate;* (3) *chlorite slate or schist*, sometimes containing octahedrons of magnetite; (4) *hydromica conglomerate*, like No. 4 above; (5) *hydromica quartzyte*, all shades occurring between hydromica slate and true quartzyte; (9) greenish-gray hydromica gneiss, containing disseminated chlorite—a kind of *protogine*—the mica pearl-white, the feldspar white, seen by the writer on the western slope of the quartzyte and hydromica ridge northeast of Rutland—the rock much like the kind from near Williamstown (No. 5 above).

B. *In Berkshire and farther south.*—(1) *Hydromica slate*, more or less chloritic, and often garnetiferous; (2) *mica slate*, that is, fine-grained mica schist; (3) *mica schist*, varying in color from a dark-gray to black, the latter a fissile rock consisting largely of black mica; (4) *garnetiferous mica schist;* (5) *quartzytic mica schist.*

Varieties of gneiss.—(6) *Fine-grained gneiss*, thin bedded, the mica in very small scales and in general mostly black, the feldspar in small white grains; (7) *the same*, but thick-bedded and very hard, color mostly light gray, the rock sometimes a *contorted gneiss;* (8) *the same*, but with little mica, the color whitish, graduating into (9) *granulyte*, a granular compound of quartz and feldspar, with only traces of mica; (10) a whitish or grayish *striped gneiss* having the mica in lines of spots or in interrupted lines, looking interruptedly striped, the mica mostly biotite; (11) *granitoid gneiss*, and (12) fine-grained *granite*, the gneiss graduating into these rocks, by a loss of its schistose structure; (13) *quartzytic gneiss*, fine-grained, whitish (often yellowish from alteration of pyrite or black mica), a rock that graduates by insensible shades into laminated quartzyte; (14) *epidotic gneiss*, containing much mica, half of which is musco-

* The occurrence of staurolite as well as garnet in the mica slate of Salisbury is mentioned by Prof. Dewey, in this Journal, vol. viii, p. 7, 1824. Earlier, in vol. v, 1822, he had announced the existence of staurolite in Sheffield.

vite, and also small green grains of epidote; (15) *syenyte gneiss*, consisting mainly of hornblende and whitish feldspar, not common; (16) *hornblende slate*, occasional beds; (17) *pyroxenyte*, consisting of white pyroxene (at Canaan, Conn.).

(18) *Garnet rock*, a firm tough rock of a blackish-gray color, consisting of quartz, pale-red garnet, some feldspar, magnetite and pyrite, and also minute disseminated prisms showing one lustrous cleavage which may be zoisite (from Beartown Mountain)—rare.

(19) *Feldspathic quartzyte*, the feldspar (orthoclase) sometimes in largish cleavable pieces, the decomposition and removal of which leaves the quartzyte cellular, looking like a buhrstone; (20) *micaceous quartzyte*, gneiss-like in aspect, but containing little or no feldspar. Besides these quartzytic rocks, and the common hard quartzyte, there is a laminated *calcareous quartzyte*, which is very porous when weathered, owing to the removal of the calcareous portion, and which has often on its surfaces minute crystals of brown tourmaline. Abrupt transitions occur between the laminated and hard massive quartzyte; the latter sometimes corresponding for a short distance to several successive beds of the former, or taking wholly its place in the formation.

3. *Schists along an East-and-West section of the limestone region.*

In Vermont.—The schists of a section across the limestone region from west to east in the line of Rutland, are the same nearly as occur in the Quartzyte group from north to south, argillyte being the only rock to the west not found to the east.

In Berkshire.—The remark just made for Vermont applies equally to Berkshire. Along an east-and-west section in southern Berkshire, there are, commencing to the west: argillyte, various kinds of hydromica slate, from a black glossy slate differing little from argillyte, to pale pearly slates, chloritic and garnetiferous hydro-mica slates; farther east, fine-grained mica schist and gneiss, coarser garnetiferous mica schist and staurolitic mica schist; and all the gneisses and other rocks mentioned above.

Thus the same kinds of rocks are met with on going from east to west across Berkshire as in going from north to south along the Quartzyte ranges of Vermont and Berkshire.

The above lists afford an idea of the great diversity in the crystalline rocks of the limestone series. We are now prepared for a conclusion.

Since then these rocks of the limestone series are conformable, and of Lower Silurian age; and since they were all crystallized into their present state after the Lower Silurian

era had nearly or quite passed, we learn—that all the various mica and chloritic schists mentioned, and the varieties of gneiss, and also, the other rocks designated, as protogine, granulyte, hornblendic, pyroxenic, epidotic and garnet rocks, were in this case a product of a single metamorphic process, acting on deposits of Lower Silurian age; and, since this wide diversity of rocks occurs in the eastern or Quartzyte portion alone of the limestone area, they have also come from that portion of the Lower Silurian to which the Quartzyte group belongs.

Consequently, if the lithological canon is a good one, neither of the rocks in the above list can be good for distinguishing formations of any other geological era than the one here considered.

But they are useless for this unless the kinds belong exclusively to it. Now no one will claim that hydromica, mica and chlorite schists, protogine, gneisses, granite, garnet and staurolitic schists, granulyte, and the rest have been derived exclusively from Lower Silurian sediments crystallized at the close of the Lower Silurian. Hence it is clear that they are not satisfactory for identifying rocks of this or any other single age. And if so, the lithological canon, as far as the varieties of these rocks described above are concerned, is not available.

The prominent point in which the gneisses and mica schists of the limestone series in Berkshire are at all peculiar is in their fineness of grain or texture. In Connecticut and farther south, the mica schists and gneisses are coarser in crystallization than those in Berkshire; so that this feature is apparently one dependent on degree of metamorphism. Temperature and rate of cooling determine the degree of coarseness (or fineness) of granular-crystalline structure in other cases, and so should it be in the metamorphic process.

One variety of the gneiss is characteristic of the eastern portion of the region—namely, the whitish kind interruptedly banded with mica spots or lines (passing into granulyte as the mica disappears). I have not observed it in New England except near the limestone region of Western Massachusetts, Connecticut and New York. The chloritic schist and chloritic hydromica schists of the series are not distinguishable from those of many other geological regions.

The lithology of the region has still some peculiarities. These are: the absence of hornblendic granite, and syenyte; the sparing occurrence of hornblende schist and hornblendic gneiss, these rocks occurring only in beds subordinate to the mica schist or true gneiss; the absence, so far as observed, of labradorite rocks; and the certain absence of granitoid labradorite rocks (those having cleavable labradorite as a prominent

constituent); the absence of chrysolite rocks, corundum-bearing rocks, and zircon-bearing rocks. Moreover, coarse flesh-colored granites and coarsely porphyritic gneiss or granite are not among the rocks mentioned.

The frequent abrupt transitions between quartzyte and gneiss is of so much interest that I may refer to it here again, and repeat that it means abrupt transitions from sand deposits to mud deposits in the old seas, just as are now common along the borders of the modern.

I may also observe, again, that the great diversity found in the crystalline rocks had nothing notable to correspond to it in the external characters of the original sediments. The hydromica and mica schists are essentially one in composition, quartz being equally a variable constituent in both; so the hydromica gneiss or protogine is nearly identical with true gneiss. A gneiss or mica schist in which the mica is black (as is commonly the case here), and a hornblendic gneiss or schist, have almost the same ultimate constitution.

In the condition of sedimentary rocks, the differences which, under metamorphism, have led to so long a list of rocks would hardly be apparent to the eye, and generally be overlooked in a description—a little difference in color, or in texture, or in proportion of sand, or in compactness, or thickness of bedding, being the chief points visible in an *unaltered* rock made of clay, mud or sand.

3. OROGRAPHIC CONCLUSIONS.

Among the orographic relations between the limestone region in Vermont and Berkshire I mention here only two.

(1.) The first relates to the positions of the rocks, and the connection between position and height.

a. Along the Central slate-belt of Vermont and its continuation in Berkshire, called the Taconic range, the slates, for the most part, have a high eastward dip; and the facts show that where this is the case they are pushed over in synclinal folds (sometimes with subordinate or local anticlinals and synclinals), the axial plane of which dips eastward.

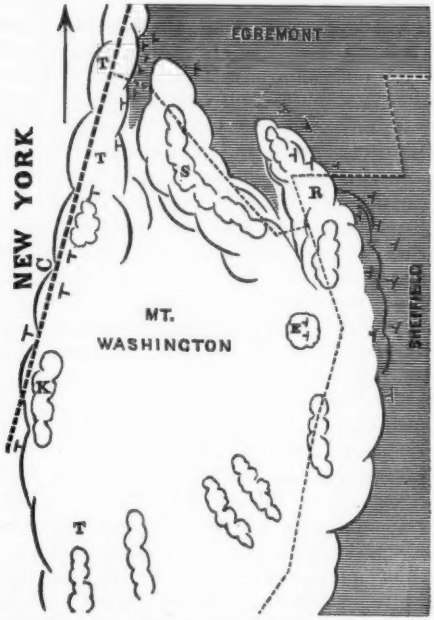
b. At intervals the slate-belt rises into peaks over 2,500 feet in height. *Such peaks occur wherever the synclinal is a broad and comparatively shallow one.*

In Vermont, this is the case in Danby Mountain, Mount Dorset or Eolus, Spruce Peak, Equinox Mountain and Mount Anthony, as illustrated on pages 346, 347, of the last volume of this Journal. The explanation is simply—that a very broad synclinal or trough holds a very large mass of mountain material; and that, on account of its magnitude, and often also its

greater compactness or hardness due to the heat and pressure, it has had its height less reduced by denudation.

Berkshire, as I have already shown,* owes its highest summits, similarly, to the occurrence of broad synclinals. Graylock, the highest, is one of them; and the Berkshire Mount Washington is another.

This feature is so remarkable and so instructive in Mount Washington, that I here reproduce the outline map of the mountain, used in a former article,* on which the position,



dip and strike of the limestone is given, the shaded area representing this rock, and the T-shaped symbols indicating the strike and dip of the rocks.* The northern portion, lettered T T, represents part of the ordinary Taconic range as it extends from Mount Washington about N. 16° E. (true), along the boundary between Massachusetts and New York, the width of which seldom exceeds a mile; while the rest of the unlined part of the map represents the area of Mount Washington, over five miles in breadth. The Taconic range, as above stated, corresponds in its narrower part to a close synclinal, with the axial plane dipping eastward. But in Mount Washington the lime-

* This Journal, II, vi, 266. The outline of the mountain is taken from the large wall-map of Berkshire, bearing the date 1858.

stone and schists at its eastern foot dip *westward* at a small angle—usually 20° to 25° (5° to 10° in the spur R); and also *westward*, but at a higher angle, in its highest summit, Mount Everett (E, on the map, 2,634 feet above the sea-level); while on the western slope the dip is throughout eastward at an average angle of 50°, the strike N. 10°–15° E. (true). Thus the broad synclinal and its contrast with the ordinary synclinal of the Taconic range is well exhibited in the position of the rocks.

c. The great breadth of this synclinal and the size of the mountain is connected also with a *compound character in the synclinal*, another common feature in orography. As remarked in a former article, the limestone of the Egremont plain extends south in two belts between the northern spurs R and S, and S and T, and each indicates a separate anticlinal fold bringing up the limestone between synclinals of the schist. It has not been possible to follow these subordinate anticlinals southward, because the limestone is not continued far in that direction, and the summit of the mountain is under soil and cultivated farms. But yet the fact of flexure at the north end is strong reason for believing that similar flexures, if not the same continued, characterize the whole length from north to south of the mountain-mass, such a slate easily flexing under uplifting lateral pressure. This is further sustained by observations proving that other subordinate anticlinals exist on the western slope of the mountain, in the vicinity of Copake Furnace. Close to the western foot there are two nearly parallel limestone areas, parallel to the axis of the range. The inner (or more eastern) one is about a mile long, and the other about half a mile. They are separated from one another by a thin belt of hydromica slate, and the same slate exists on the other sides. The dip of the beds of limestone and slate is to the eastward 50°, the strike averaging N. 15° E. (true). They are evidently registers of local folds—anticlinal and synclinal, the former bringing up the limestone. Such flexures are not distinguishable in the schists unless sufficiently profound to bring up the limestone; for the dip is throughout to the eastward; and hence there may be many of these subordinate anticlinals and synclinals in the broad mass where there is nothing to prove it. In the memoir referred to I have mentioned some evidence that the Graylock mountain-mass, while a broad synclinal, comprises one or more subordinate anticlinals and synclinals. It is a point to be considered in the study of all mountain-masses consisting of steeply flexed rocks.

In another place in this volume, I speak of the Mt. Washington range in New Hampshire, east of the principal valley, as probably corresponding to a synclinal. I would here add that it may be a

compound synclinal, and to this owe the apparently great thickness of its andalusitic mica schists. Flexures of less span than five miles, and much less, are far more common among steeply dipping rocks than those of greater extent, and simply because, under the pressure producing such bold upturnings shaly strata cannot help flexing at narrow intervals, so as to have frequent local flexures subordinate to the larger folds.

2. The uniformity in character of the long Taconic slate-belt from Weybridge in Vermont to Salisbury and Sharon in Connecticut, and of the adjoining limestone through a still longer range, and the parallelism of the whole in position and strike with the more eastern ranges of quartzyte and schist, and parallelism, also, with the axis of the Green Mountain elevation, show that the uplifting force corresponded entirely in direction of action with that in which the Green Mountains were made, and, further, that it was sufficient in power to produce vast flexures of strata over an area of great extent. One of the summits in the Taconic range is but 600 feet lower than the highest in the more easterly Green Mountain series; and others, both in Vermont and Berkshire, are little inferior in elevation. Moreover, those of Berkshire and of the adjoining part of Connecticut far overtop all ridges to the eastward, and really constitute in those latitudes the most elevated portion of the Green Mountain system. Yet the width of the area which has been under consideration hardly anywhere exceeds twenty miles.

The magnitude of the results are strong evidence that the so-called limestone-area is really but a small part of a larger region of cotemporaneous disturbance and uplift. The true breadth of the area, as well as length—whether it reached to the Connecticut Valley on the east and to the Hudson River Valley on the west, and so had the breadth of the Appalachian disturbance of a later epoch, or whether it had narrower limits—may be ascertained by studying the stratification. Some of the results of such a study as regards Connecticut and a portion of New York I propose to give in another paper.

Note.—Of the two fossils from the quartzyte of Vermont, referred to on page 207 of this volume, the theca-like species—or so-called Orthoceras—has a rather close resemblance to the species of Hyolithes from the Primordial near Troy, New York, described and figured in this Journal, volume iii, for 1872, by Mr. S. W. Ford; and, were that the only species, there would seem to be ground for a strong suspicion that the quartzyte is Primordial. But the Lamellibranch shells (the other species) are even stronger evidence, in the present state of paleontological discovery, that the rock is later than Primordial. As before stated, more fossils are needed for a conclusion.

ART. XXXV.—*Address before the Department of Anthropology of the British Association, at Plymouth;* by FRANCIS GALTON, F.R.S.

PERMIT me to say a few words of personal explanation to account for the form of the address I am about to offer. It has been the custom of my predecessors to give an account of recent proceedings in anthropology, and to touch on many branches of that wide subject. But I am at this moment unprepared to follow their example with the completeness I should desire and you have a right to expect, owing to the suddenness with which I have been called upon to occupy this chair. I had indeed the honor of being nominated to the post last spring, but circumstances arising which made it highly probable that I should be prevented from attending this meeting, I was compelled to ask to be superseded. New arrangements were then made by the Council, and I thought no more about the matter. However, at the last moment, the accomplished ethnologist who otherwise would have presided over you, was himself debarred by illness from attending, and the original plan had to be reverted to.

Under these circumstances I thought it best to depart somewhat from the usual form of addresses, and to confine myself to certain topics with which I happen to have been recently engaged, even at the risk of incurring the charge of submitting to you a memoir rather than an address.

I propose to speak of the study of those groups of men who are sufficiently similar in their mental characters or in their physiognomy, or in both, to admit of classification; and I especially desire to show that many methods exist of pursuing the inquiry in a strictly scientific manner, although it has hitherto been too often conducted with extreme laxity.

The types of character of which I speak are such as those described by Theophrastus, La Bruyére, and others, or such as may be read of in ordinary literature and are universally recognized as being exceedingly true to nature. There are no worthier professors of this branch of anthropology than the writers of the higher works of fiction, who are ever on the watch to discriminate varieties of character, and who have the art of describing them. It would, I think, be a valuable service to anthropology if some person well versed in literature were to compile a volume of extracts from novels and plays that should illustrate the prevalent types of human character and temperament. What, however, I especially wish to point out is, that it has of late years become possible to pursue an inquiry into certain fundamental qualities of the mind by the aid of exact

measurements. Most of you are aware of the recent progress of what has been termed psycho-physics, or the science of subjecting mental processes to physical measurements and to physical laws. I do not now propose to speak of the laws that have been deduced, such as that which is known by the name of Fechner, and its numerous offshoots, including the law of fatigue, but I will briefly allude to a few instances of measurement of mental processes, merely to recall them to your memory. They will show what I desire to lay stress upon, that the very foundations of the differences between the mental qualities of man and man admit of being gauged by a scale of inches and a clock.

Take, for example, the rate at which a sensation or a volition travels along the nerves, which has been the subject of numerous beautiful experiments. We now know that it is far from instantaneous, having indeed no higher velocity than that of a railway express train. This slowness of pace, speaking relatively to the requirements that the nerves have to fulfill, is quite sufficient to account for the fact that very small animals are quicker than very large ones in evading rapid blows, and for the other fact that the eye and the ear are situated in almost all animals in the head, in order that as little time as possible should be lost on the road, in transmitting their impressions to the brain. Now the velocity of the complete process of to and fro nerve transmission in persons of different temperaments has not been yet ascertained with the desired precision. Such difference as there may be is obviously a fundamental characteristic and one that well deserves careful examination. I may take this opportunity of suggesting a simple inquiry that would throw much light on the degree in which its velocity varies in different persons, and how far it is correlated with temperament and external physical characteristics. Before I describe the inquiry I suggest, and toward which I have already collected a few data, it is necessary that I should explain the meaning of a term in common use among astronomers, namely, "personal equation." It is a well-known fact that different observers make different estimates of the exact moment of the occurrence of any event. There is a common astronomical observation, in which the moment has to be recorded at which a star that is traveling athwart the field of view of a fixed telescope, crosses the fine vertical wire by which that field of view is intersected. In making this observation it is found that some observers are over sanguine and anticipate the event, while others are sluggish and allow the event to pass by before they succeed in noting it. This is by no means the effect of inexperience or maladroitness, but it is a persistent characteristic of each individual, however practiced in the art of making observations or

however attentive he may be. The difference between the time of a man's noting the event and that of its actual occurrence is called his personal equation. It remains curiously constant in every case for successive years, it is carefully ascertained for every assistant in every observatory, it is published along with his observations, and is applied to them just as a correction would be applied to measurements made by a foot-rule, that was known to be too long or too short by some definite amount. Therefore the magnitude of a man's personal equation indicates a very fundamental peculiarity of constitution; and the inquiry I would suggest, is to make a comparison of the age, height, weight, color of hair and eyes, and temperament (so far as it may admit of definition) in each observer in the various observatories at home and abroad, with the amount of his personal equation. We should thus learn how far the more obvious physical characteristics may be correlated with certain mental ones, and we should perhaps obtain a more precise scale of temperaments than we have at present.

Another subject of exact measurement is the time occupied in forming an elementary judgment. If a simple signal be suddenly shown, and if the observer presses a stop as quickly as he can when he sees it, some little time will certainly be lost, owing to delay in nerve transmission and to the sluggishness of the mechanical apparatus. In making experiments on the rate of judgment, the amount of this interval is first ascertained. Then the observer prepares himself for the exhibition of a signal that may be either black or white, but he is left ignorant which of the two it will be. He is to press a stop with his right hand in the first event, and another stop with his left hand in the second one. The trial is then made, and a much longer interval is found to have elapsed between the exhibition of the alternative signal, and the record of it, than had elapsed when a simple signal was used. There has been hesitation and delay: in short, the simplest act of judgment is found to consume a definite time. It is obvious that here, again, we have means of ascertaining differences in the rapidity of forming elementary judgments, and of classifying individuals accordingly.

It would be easy to pursue the subject of the measurement of mental qualities to considerable length, by describing other kinds of experiment, for they are numerous and varied. Among these is the plan of Professor Jevons, of suddenly exhibiting an unknown number of beans in a box, and requiring an estimate of their number to be immediately called out. A comparison of the estimate with the fact, in a large number of trials, brought out a very interesting scale of the accuracy of such estimates, which would of course vary in different individuals, and might be used as a means of classification. I can

imagine few greater services to anthropology than the collection of the various experiments that have been imagined to reduce the faculties of the mind to exact measurement. They have engaged the attention of the highest philosophers, but have never, so far as I am aware, been brought compendiously together, and have certainly not been introduced, as they deserve, to general notice.

Wherever we are able to perceive differences by inter-comparison, we may reasonably hope that we may at some future time succeed in submitting those differences to measurement. The history of science is the history of such triumphs. I will ask your attention to a very notable instance of this, namely, that of the establishment of the scale of the thermometer. You are aware that the possibility of making a standard thermometric scale wholly depends upon that of determining two fixed points of temperature, the interval between them being graduated into a scale of equal parts. These points are, I need hardly say, the temperatures of freezing and of boiling water respectively. On this basis we are able to record temperature with minute accuracy, and the power of doing so has been one of the most important aids to physics and chemistry as well as to other branches of investigation. We have been so accustomed, from our childhood, to hear of degrees of temperature, and our scientific knowledge is so largely based upon exact thermometric measurement, that we cannot easily realize the state of science when the thermometer, as we now use it, was unknown. Yet such was the condition of affairs so recently as two hundred years ago, or thereabouts. The invention of the thermometer, in its present complete form, was largely due to Boyle, and I find in his "Memoirs" (London, 1772, vol. vi, p. 403), a letter that cannot fail to interest us, since it well expresses the need of exact measurement that was then felt in a particular case, where it was soon eminently well supplied, and therefore encourages hope that our present needs as anthropologists may hereafter, in some way or other, be equally well satisfied. The letter is from Dr. John Beale, a great friend and correspondent of Boyle, and is dated February, 1663. He says in it:—

"I see by several of my own thermometers that the glassmen are by you so well instructed to make the stems in equal proportions, that if we could name some degrees, ... we might by the proportions of the glass make our discourses intelligible in mentioning what degrees of cold our greatest frosts do produce. . . . . If we can discourse of heat and cold in their several degrees, so as we may signify the same intelligibly, ... it is more than our forefathers have taught us to do hitherto."

The principal experiments by which the mental faculties may be measured require, unfortunately for us, rather costly and delicate apparatus, and until physiological laboratories are more numerous than at present, we can hardly expect that they will be pursued by many persons.

Let us now suppose that, by one or more of the methods I have described or alluded to, we have succeeded in obtaining a group of persons resembling one another in some mental quality, and that we desire to determine the external physical characteristics and features most commonly associated with it. I have nothing new to say as regards the usual anthropometric measurements, but I wish to speak of the great convenience of photographs in conveying those subtle but clearly visible peculiarities of outline which almost elude measurement. It is strange that no use is made of photography to obtain careful studies of the head and features. No single view can possibly exhibit the whole of a solid, but we require for that purpose views to be taken from three points at right angles to one another. Just as the architect requires to know the elevation, side view, and plan of a house, so the anthropologist ought to have the full face, profile, and view of the head from above of the individual whose features he is studying.

It might be a great convenience, when numerous portraits have to be rapidly and inexpensively taken for the purpose of anthropological studies, to arrange a solid framework supporting three mirrors, that shall afford the views of which I have been speaking, by reflection, at the same moment that the direct picture of the sitter is taken. He would present a three-quarter face to the camera for the direct picture, one adjacent mirror would reflect his profile towards it, another on the opposite side would reflect his full face, and a third sloping over him would reflect the head as seen from above. All the reflected images would lie at the same optical distance from the camera, and would, therefore, be on the same scale, but they would be on a somewhat smaller scale than the picture taken directly. The result would be an ordinary photographic picture of the sitter surrounded by three different views of his head. Scales of inches attached to the framework would appear in the picture and give the means of exact measurement.

Having obtained drawings or photographs of several persons alike in most respects, but differing in minor details, what sure method is there of extracting the typical characteristics from them? I may mention a plan which had occurred both to Mr. Herbert Spencer and myself, the principle of which is to superimpose optically the various drawings and to accept the aggregate result. Mr. Spencer suggested to me in conversation that the drawings reduced to the same scale might be traced on sep-

arate pieces of transparent paper and secured one upon another, and then held between the eye and the light. I have attempted this with some success. My own idea was to throw faint images of the several portraits, in succession, upon the same sensitized photographic plate. I may add that it is perfectly easy to superimpose optically two portraits by means of a stereoscope, and that a person who is used to handle instruments will find a common double eye-glass fitted with stereoscopic lenses to be almost as effectual and far handier than the boxes sold in shops.

In illustration of what I have said about photographic portraits, I will allude to some recent experiences of my own in a subject that I have still under consideration. In previous publications I have treated of men who have been the glory of mankind, I would now call your attention to those who are its disgrace. The particular group of men I have in view are the criminals of England, who have been condemned to long terms of penal servitude for various heinous offences.

It is needless to enlarge on the obvious fact that many persons have become convicts who, if they had been afforded the average chances of doing well, would have lived up to a fair standard of virtue. Neither need I enlarge on the other equally obvious fact, that a very large number of men escape criminal punishment, who in reality deserve it quite as much as an average convict. Making every allowance for these two elements of uncertainty, no reasonable man can entertain a doubt that the convict class includes a large proportion of consummate scoundrels, and that we are entitled to expect to find in any large body of convicts a prevalence of the truly criminal characteristics, whatever these may be.

Criminality, though not very various in its development, is extremely complex in its origin: nevertheless, certain general conclusions are arrived at by the best writers on the subject, among whom I would certainly rank Prosper Despine. The ideal criminal has three peculiarities of character; his conscience is almost deficient, his instincts are vicious, and his power of self-control is very weak. As a consequence of all this, he usually detests continuous labor. This statement applies to the criminal classes generally, the special conditions that determine the description of crime being the character of the instincts; and the fact of the absence of self-control being due to ungovernable temper, or to passion, or to mere imbecility.

The deficiency of conscience in criminals, as shown by the absence of genuine remorse for their guilt, appears to astonish all who first become familiar with the details of prison life. Scenes of heartrending despair are hardly ever witnessed among prisoners; their sleep is broken by no uneasy dreams—on the

contrary, it is easy and sound; they have also excellent appetites. But hypocrisy is a very common vice; and all my information agrees in one particular, as to the utter untruthfulness of criminals, however plausible their statements may appear to be.

The subject of vicious instincts is a very large one; we must guard ourselves against looking upon them as perversions, inasmuch as they may be strictly in accordance with the healthy nature of the man, and, being transmissible by inheritance, may become the normal characteristics of a healthy race, just as the sheep-dog, the retriever, the pointer, and the bull-dog have their several instincts. There can be no greater popular error than the supposition that natural instinct is a perfectly trustworthy guide, for there are striking contradictions to such an opinion in individuals of every description of animal. All that we are entitled to say is, that the prevalent instincts of each race are trustworthy, not those of every individual. A man who is counted as an atrocious criminal by society, and is punished as such by the law, may nevertheless have acted in strict accordance with his instincts. The ideal criminal is deficient in qualities that oppose his vicious instincts; he has neither the natural regard for others which lies at the base of conscience, nor has he sufficient self-control to enable him to consider his own selfish interests in the long run. He cannot be preserved from criminal misadventure, either by altruistic or by intelligently egoistic sentiments.

It becomes an interesting question to know how far these peculiarities may be correlated with physical characteristics and features. Through the cordial and ready assistance of Sir Edmund Du Cane, the Surveyor-General of Prisons, who has himself contributed a valuable memoir to the Social Science Congress on the subject, I was enabled to examine the many thousand photographs of criminals that are preserved for purposes of identification at the Home Office, to visit prisons and confer with the authorities, and lastly to procure for my own private statistical inquiries a large number of copies of photographs of heinous criminals. I may as well say, that I begged that the photographs should be furnished me without any names attached to them, but simply classified in three groups according to the nature of the crime. The first group included murder, manslaughter, and burglary; the second group included felony and forgery; and the third group referred to sexual crimes. The photographs were of criminals who had been sentenced to long terms of penal servitude.

By familiarizing myself with the collection, and continually sorting the photographs in tentative ways, certain natural classes began to appear, some of which are exceedingly well

marked. It was also very evident that the three groups of criminals contributed in very different proportions to the different physiognomic classes.

This is not the place to go further into details: indeed my inquiry is far from complete. I merely quote my experiences in order to show the way in which questions of character, physiognomy, and temperament admit of being scientifically approached, and to give an instance of the helpfulness of photography. If I had had the profiles and the shape of the head as seen from above, my results would have been much more instructive. Thus, to take a single instance, I have seen many pencil studies in outline of selected criminal faces drawn by Dr. Clarke, the accomplished and zealous medical officer of Pentonville Prison; and in these sketches a certain very characteristic profile seemed to me conspicuously prevalent. I should have been very glad of photographs to corroborate this. So, again, if I had had photographic views of the head taken from above, I could have tested, among other matters, the truth of Professor Benedict's assertion about the abnormally small size of the back of the head in criminals.

I have thus far spoken of the characters and physiognomy of well-marked varieties of men: the anthropologist has next to consider the life history of those varieties, and especially their tendency to perpetuate themselves, whether to displace other varieties and to spread, or else to die out. In illustration of this, I will proceed with what appears to be the history of the criminal class. Its perpetuation by heredity is a question that deserves more careful investigation than it has received, but it is on many accounts more difficult to grapple with than it may at first sight appear to be. The vagrant habits of the criminal classes, their illegitimate unions and extreme untruthfulness, are among the difficulties. It is, however, easy to show that the criminal nature tends to be inherited while, on the other hand, it is impossible that women who spend a large portion of the best years of their lives in prison can contribute many children to the population. The true state of the case appears to be that the criminal population receives steady accessions from classes who, without having strongly marked criminal natures, do nevertheless belong to a type of humanity that is exceedingly ill-suited to play a respectable part in our modern civilization, though they are well-suited to flourish under half-savage conditions, being naturally both healthy and prolific. These persons are apt to go to the bad; their daughters consort with criminals and become the parents of criminals. An extraordinary example of this is given by the history of the infamous Jukes family in America, whose pedigree has been made out with extraordinary care, during no less than seven generations, and is the subject of an elaborate memoir printed in the

thirty-first annual report of the Prison Association of New York, 1876. It includes no less than 540 individuals of Jukes blood, among whom the number of persons who degraded into criminality, pauperism, or disease, is frightful to contemplate.

It is difficult to summarize the results in a few plain figures, but I will state those respecting the fifth generation, through the eldest of the five prolific daughters of the man who is the common ancestor of the race. The total number of these was 103, of whom thirty-eight came through an illegitimate granddaughter, and eighty-five through legitimate grand-children. Out of the thirty-eight, sixteen have been in jail, six of them for heinous offences, one of these having been committed no less than nine times; eleven others were paupers or led openly disreputable lives; four were notoriously intemperate; the history of three had not been traced, and only four were known to have done well. The great majority of the women consorted with criminals. As to the eighty-five legitimate descendants, they were less flagrantly bad, for only five of them had been in jail and only thirteen others had been paupers. Now the ancestor of all this mischief, who was born about the year 1730, is described as having been a hunter and a fisher, a jolly, companionable man, averse to steady labor, working hard and idling by turns, and who had numerous illegitimate children, whose issue has not been traced. He was, in fact, a somewhat good specimen of a half-savage, without any seriously criminal instincts. The girls were apparently attractive, marrying early and sometimes not badly; but the gipsy-like character of the race was unsuited to success in a civilized country. So the descendants went to the bad, and the hereditary moral weaknesses they may have had rose to the surface and worked their mischief without a check. Cohabiting with criminals and being extremely prolific, the result was the production of a stock exceeding 500 in number, of a prevalent criminal type. Through disease and intemperance the breed is now rapidly diminishing; the infant mortality has of late been horrible among them, but fortunately the women of the present generation bear usually but few children, and many of them are altogether childless.

This is not the place to go further into details. I have alluded to the Jukes family in order to show what extremely important topics lie open to inquiry in a single branch of anthropological research, and to stimulate others to follow it out. There can be no more interesting subject to us than the quality of the stock of our countrymen and of the human race generally, and there can be no more worthy inquiry than that which leads to an explanation of the conditions under which it deteriorates or improves.

ART. XXXVI.—*Analyses of Cast Nickel, and Experiments on the combining of Carbon and Silicon with Nickel;* by WILLIAM E. GARD. Contributions from the Sheffield Laboratory of Yale College. No. L.

NUMEROUS analyses of commercial nickel have been published, according to which the usual impurities of this product are cobalt, iron, copper, sulphur, arsenic, alumina, alkaline earths and silica, in very varying quantities. In a few cases carbon is reported.

In text-books of metallurgy it is usually stated that the final step in the process of preparing commercial nickel is to reduce the oxide in the form of lumps or cubes without fusion by means of charcoal. According to Kerl,* the already reduced outside portion of the cube takes up carbon by contact and transfers it to the interior. If the reduced metal be allowed to remain in contact with the coal at a high temperature, it takes up more and more carbon. It is also stated in Gmelin's Handbook of Chemistry,† on the authority of Döbereiner, that nickel takes up carbon.

The nickel plates now largely used as anodes for nickel plating are prepared by fusing commercial nickel, generally with addition of charcoal, and casting in suitable form. The process of fusion could hardly be expected to effect much change in composition beyond the removal of intermixed oxides, as alumina, alkaline earths and silica. The subjoined analyses show, however, that silica may be reduced and retained as silicon, and that a considerable amount of carbon may be present.

	No. I.		No. II.		No. III.	
	a	*b*	*a*	*b*	*a*	*b*
Carbon,	·530	·549	1·104	1·080	1·900	1·830
Silicon,	·303	·294	·130	·125	·255	·268
Iron,	·464	·463	·108	·110	·301	·318
Cobalt,	·446	·438	trace		trace	
Sulphur,	·049	·057	·266	·340	·104	·096
[Nickel],	98·208	98·199	98·392	98·345	97·440	97·488
	100·000	100·000	100·000	100·000	100·000	100·000

Carbon was estimated by the method that is generally employed in this laboratory for its determination in iron, viz: treatment with solution of perfectly neutral normal cupric chloride, or of cupric ammonium chloride, and combustion of the residue after washing on an asbestos filter. The action of

* Handbuch der metallurg. Hüttenkunde, vol. iv, p. 482, 1865.
† Vol. v, p. 366, 1851.

cupric chloride on nickel is extremely slow, two or three weeks being required for the solution of five grams, although crushed fine in a steel mortar. The cupric ammonium chloride is a better solvent, two or three days sufficing for the solution. Of the subjects of analysis, No. I was American nickel, manufactured and cast by Jos. Wharton at Camden, N. J. A careful examination by means of Marsh's apparatus showed not the least trace of arsenic or antimony. No. II was a sample taken from a cast nickel anode used by a nickel plating establishment in New Haven. No. III, a sample taken from the same anode after it had been used in the plating bath until upward of half its weight had been removed. Solvent action had extended quite through the plate, leaving as usual a porous flexible mass retaining its original form. A comparison of Nos. II and III shows that under galvanic action the carbon, silicon and iron of the anode dissolve relatively slower than nickel, while the reverse happens with sulphur.

Experiments.

It is well known that when oxide of iron is reduced by carbon at a high temperature in presence of silica, a portion of the latter is simultaneously reduced and combined with the iron. To ascertain the deportment of silicon to nickel under similar conditions, the following experiment was made. A quantity of pure nickel oxide was intimately mixed with about half its weight of finely pulverized quartz, and enough charcoal powder to effect reduction of both. The mass was made into pellets with starch paste, dried, ignited and finally, with addition of more charcoal, exposed to an intense heat for three hours. A perfectly fused metallic button was obtained, white, homogeneous in structure, soft enough to be easily drilled, having a specific gravity of 7·73. The smallest particles were not attracted by an ordinary magnet. It was found to contain

Carbon	8·90	9·50
Silicon	6·039	6·190

In order to obtain further knowledge in regard to the amount of carbon which nickel may take up under conditions to which it is more or less exposed in the processes of manufacture and casting, half a pound of granular commercial nickel was packed in layers with charcoal in a Hessian crucible and exposed to a full red heat twelve hours. Examination of the contents of the crucible showed that no fusion had taken place. The temperature was then raised until complete fusion ensued. The resulting metal was strongly magnetic, quite soft and to a considerable extent malleable. It possessed a specific gravity of 8·04, and a fracture resembling that of fine-grained grey pig-

iron, scales of graphite being plainly visible. It was found to contain:

	a	*b*
Total carbon	2·105	2·130
Graphitic carbon ..	2·030	1·990
Silicon	·360	....

To ascertain the deportment of nickel and cobalt toward hydrocarbon at high temperature, the following substances were placed in a platinum trough within a porcelain tube and treated with a slow current of pure dry marsh gas at a full red heat.

No. 1, thin plates of electroplate nickel—which a careful examination proved to be free from impurities. No. 2, nickel prepared by reducing pure oxide by hydrogen. No. 3, fine soft iron wire. No. 4, cobalt prepared from pure oxalate by ignition and reduction with hydrogen. These metals were first ignited in the porcelain tube with hydrogen and weighed. Three exposures to a red heat with a current of marsh gas were then made, the metals being weighed each time after cooling in the current of gas. A portion of the electro-plate nickel was used for examination after the second exposure, so that an amount equal to ·5638 grams was present at the last heat.

A condensed statement of the result is exhibited in the following tables, in which the first column contains the original weights of the metals; the second, third and fourth, the total increase in weight after successive treatments; and the fifth shows the percentage of carbon in the final resulting compounds, assuming that the gain was due exclusively to this element.

Weights of metals.		Gain in 3½ hours.	Gain in 4½ hours.	Gain in 6½ hours.	% C. at close.
1. Ni,	·8597	·0067	·0823	[·0672]	10·649
2. Ni,	1·9008	·0046	·0071	·0114	5·96
3. Fe,	1·2837	·0078	·0096	·0103	·795
4. Co,	1·2697	·0758	·1680	·1857	12·758

No deposit of carbon could be detected on any part of the apparatus or on the metals at the close of the operation. The iron and nickel No. 2 were unchanged in appearance. The cobalt was somewhat blackened. It was as first prepared very porous and spongy; a part of its increase in weight may have been due to deposited carbon. Nickel No. 2 was in the form of coarse compact grains presenting comparatively little surface. The electro-plate nickel at the end of the operations had become brittle, and resembled gas carbon in color and luster; treatment with nitric acid readily dissolved the nickel, leaving a spongy mass of easily combustible carbon. A broken sur-

face appeared under the microscope homogeneous, granular, with dull metallic luster. When ground to fine powder with water all settled rapidly and every particle was strongly attracted by the magnet. These properties seem to render it probable that the carbon was all in a combined state.

ART. XXXVII.—*On the practical use of Autography, especially for Natural History publications.* Condensed from a letter to the Christiania paper "Morgenbladet," 1875, by G. O. SARS, Professor of Zoology at the University of Christiania, Norway, and translated by J. LINDAHL.

AUTOGRAPHY is a long-known process by which manuscript, or drawings, made on common paper by means of a peculiar kind of ink, may be transferred to a lithographic stone and then printed. This simple and cheap method has, however, had hitherto a very limited practical use, and almost exclusively for the reproduction of original manuscripts, hieroglyphs, or other simple figures, for which types could not be used. In Norway it was introduced in 1873, by Dr. Lieblein, who illustrated his Egyptological work with some pages of hieroglyphic inscriptions reproduced in autography. This suggested to me the idea that the same process might answer also for representing simple zoological objects, and thus afford the means of removing one of the great impediments that too often have interfered with a free development of zoology, viz: the heavy expense connected with a production in the usual way—by lithography or copper plate engraving—of illustrations so necessary for all works on descriptive zoology. * * * There are a number of objections to the autographic process hitherto used, and these led me to experiment on the subject. I have been fortunate enough by my experiments to devise an easy method and to prove its extensive practical use, and it gives me pleasure to communicate it to the scientific world, believing that I am doing science an important service. I must add that the success of my experiments is greatly due to Mr. Fehr's warm interest and assistance.

The following is a detailed explanation of this improved autographic process. The drawing is done on common paper, not too thick (for instance common letter paper), which, on one side (where the drawing is to be made), has been coated, by means of a sponge, with a thin film of starch. As it is not well for the shading to use quite glossy paper, it is a good way to give it a granulated surface by pressing it against a lithographic stone. By using for this purpose stones with more or

less smooth surface, the paper will assume any degree of smoothness required, according to the character of the drawing. The next process is to fasten the paper to a sketching board or a piece of pasteboard; the drawing is then made by means of the lithographic crayon. I use a kind of crayon containing copal ("*crayons copal*") and therefore less brittle than the common kind: and as this kind is also in other respects preferable, it had better always be used for this purpose. It can be obtained in small boxes from Monsieur Lemercier, Rue de Seine, St. Gn., 57, Paris.

The paper must be cut to the size intended for a full plate, and the drawings arranged in the same order as they will have to appear in the printed plate. The execution is exceedingly simple, and any draughtsman will easily acquire the necessary skill in the work. The method is the same as in common drawing with lead pencil, or rather crayon. The figures should, however, first be sketched in outline on common paper and then transferred to the prepared paper in the usual manner, by means of transparent paper and plumbago paper, blue paper, or, still better, red paper, the transferring being done with a lead pencil that is not too soft. The details of the figures, the shading and finer structural conditions may be drawn off-hand with the crayon on the prepared paper, after the outline has been transferred. Any correction or change in the drawing can easily be done by erasing with a fine scalpel, taking care only that the starch film be not injured. I have in this way made numerous corrections in my drawings without the slightest injury to the prints. When the plate is finished to satisfaction, it is transferred to a common smooth lithographic stone, in the following simple way. The back of the paper is moistened with water containing a small portion of nitric acid; and, after having been put for some time between moistened soft printing paper, the plate is laid, face downward, on the stone, which then for a moment is put in the press. To make more sure of it the outside of the paper may be slightly rubbed with the finger; if then the paper be stripped off, the drawing and the entire film of starch will remain on the stone, the figures being reversed. Now the stone is to be treated in the common way with gum arabic and a weak etching, and will then be ready for printing. The whole process of transferring the drawing from the paper to the stone is simple, but requires practice and great care. This should therefore be left to the charge of a professional lithographer.

It may be thought that the zoologist, by taking on himself the execution of his plates, would have his labor excessively increased. This, however, is not really so. The drawing must at all events be made by the zoologist in one way or another

before the lithographer or engraver can copy them, and it is of no material difference to the former whether he makes them with lead pencil or in the above described manner. The only difference is that he must himself arrange his figures on the plates, and not, as otherwise is the practice, leave this to the lithographer; and besides, he must draw all the figures that are to go on one plate in as far as possible a continuous sequence. But this increase of labor is of small account compared with the great and essential advantages offered by this method, viz:

1. *Cheapness.*—The expenses of such a plate are reduced simply to the cost of paper and printing, and will be even less than for a page of common printed matter. Thus any zoologist who publishes his researches can illustrate his papers with any number of plates, without meeting the insurmountable obstacle of enormous expense, which too often has rendered illustration of such papers impossible.

2. *Correctness.*—It avoids the errors that come from the copying of drawings by the engraver.

3. *Quick execution.*—The author and publisher are independent of the greater or smaller expedition of the engraver. I know of many instances of the delay of important researches from this cause for years, with great detriment to the author and his works. Nothing can be more unpleasant to a working zoologist than to be forestalled in this way in his researches. All this may be avoided by using this autographic method. The plates once drawn, the whole edition can be pushed through the press within the course of a few days.

Against these great and obvious advantages it may be said that only those zoologists can avail themselves of the process who know how to draw. To this it may be answered that the knowledge of drawing is indispensable to a zoologist now-a-days. In many instances even the best draughtsman is of no use as assistant to a zoologist. In many cases, especially in microscopical researches, only a momentary flash, so to say, illuminates certain questions of importance. Such a flash must be perceived by the zoologist and so fully understood that he immediately can give a representation on paper of what he has seen, and consequently it is generally necessary that the draughtsman should be a zoologist.

Some modern zoologists have, to save expense, tried to make their drawings directly on the stone. Such a plate will of course have the value of an autographic drawing. But it requires unusual practice and a special study of the lithographic art, which can be expected of only a very small number of zoologists. It is obvious that the same result is obtained by the above described method, and in a far easier way.

ART. XXXVIII.—*On the Iodates of Cobalt and Nickel; some Specific Gravity determinations; and an Analysis of Sylvanite from Colorado;* by F. W. CLARKE, Professor of Physics and Chemistry. Numbers IV, V, and VI, of Laboratory Notes, from the University of Cincinnati.

IV. *On the Iodates of Cobalt and Nickel.*

ABOUT forty years ago Rammelsberg described the iodates of cobalt and nickel.* He dissolved the freshly precipitated carbonates of the metals in an aqueous solution of iodic acid, and, upon concentrating, obtained the salts in the form of crystalline crusts. To the cobalt salt he assigned a quantity of water of crystallization represented by $1\frac{1}{2}$ molecules, while the nickel iodate was found to be monohydrated.

During the winter of 1876–1877 I put one of my laboratory students, Mr. H. B. Fullerton, at work upon the iodates, requiring him, among other salts, to prepare the two in question. Rammelsberg's mode of preparation was followed, and results somewhat different from his obtained.

When cobalt carbonate is dissolved in aqueous iodic acid and the filtered solution evaporated rapidly over a flame, Rammelsberg's iodate readily separates out, nearly the whole of the salt being deposited in a very few moments. But when, on the other hand, the solution is allowed to evaporate spontaneously, small red crystals are formed, having the composition $CoI_2O_6 . 6H_2O$. This is evidently the normal iodate, since it contains the same number of molecules of water as are found in the chlorate, bromate, nitrate, chloride, bromide, iodide, hypophosphite, hyposulphite, dithionate, selenate, and numerous other salts. Indeed, a large majority of the known salts not only of cobalt and nickel, but also of zinc and magnesium, crystallize with six molecules of water. So general does this rule appear to be that all exceptions to it ought to receive the most careful scrutiny. Even the sulphates of these metals, crystallized at temperatures above 60° C., are well known to be hexhydrated.

The new cobalt iodate differs strongly in color from the one discovered by Rammelsberg, being not a true purple, but distinctly red like the nitrate. The percentage of cobalt found was 11·10, the theoretical quantity being 11·24. Heated to 135°, the salt loses 13·73 per cent of water. Four molecules correspond to 13·95 per cent. The remaining two molecules of water could not be expelled without partially decomposing the iodate. The specific gravity is 3·6426, at 16°; and 3·6893 at

* Poggendorff's Annalen, vol. xliv, p. 545.

21°. Rammelsberg's salt gave 5·0275 at 17°, and 4·9885 at 19°. These determinations were made by weighing in benzol with an ordinary specific gravity flask.

The iodate of nickel was prepared in a manner precisely corresponding to that which yielded the cobalt compound, and separated out in small green crystals resembling in color the nitrate. These also proved to be hexhydrated, and contained, according to Mr. Fullerton's analysis, 11·15 per cent of nickel. Theory, 11·41. Specific gravity, 3·6954 at 22°. Want of time prevented a more complete examination of this salt. An attempt was made to prepare the monohydrated iodate of Rammelsberg, but without success. I hope that at some time in the near future I may be able to get farther results concerning these and one or two other iodates, as there are various points about them which need to be cleared up. The work of Mr. Fullerton, however, shows conclusively that the true normal iodates of cobalt and nickel contain really six molecules of water of crystallization, and that they are essentially different from the salts obtained by Rammelsberg.

V. *Some Specific Gravity Determinations.*

During the past academic year the laboratory students in the University of Cincinnati have determined the densities of a considerable number of salts. Many of these salts had not been determined before; some of the determinations confirm the work of other investigators, and there are also some important corrections of older, published figures. The work has been done in connection with the regular laboratory routine, and upon the following plan. Every student, in addition to the usual exercises in qualitative analysis, has been required to do a certain amount of preparative work, and to determine the specific gravity of each substance prepared. It is understood by the student, in advance, that the substances to be chosen are as a rule those of which the density is unknown, and thus he realizes that his work is actually adding something to the data of science. In short, every student is absolutely required to determine some new fact for himself, and to determine it accurately. The work is done under my own personal supervision, and a sufficient number of checks are put upon it to render it reliable. The weighings, with a few exceptions, have been made in benzol, as in the case of the iodates already described. In three instances only were the weighings made in water. The figures, however, all refer to water as unity, taken at its temperature of maximum density.

To Mr. H. B. Fullerton, as I have already stated, was assigned the iodates. In addition to the figures for the cobalt and nickel salts, he obtained the following data.

Barium iodate, BaI_2O_6, precipitated and carefully dehydrated, 5·2179, 5·1853, 5·2855, at 18°.

Silver iodate, $AgIO_3$, precipitated, 5·4023, 16·5°. The same salt recrystallized from ammonia gave 5·6475, 14·5°.

Lead iodate, PbI_2O_6, precipitated, 6·1783, at 19°, and 6·1322, 21°. For this salt Schröder found 6·209. These three iodates were weighed in water.

Ammonium iodate, $NH_4.IO_3$, small crystals, 3·3085, 21°; and 3·3372, 12·5°.

Mr. Fullerton also determined the specific gravities of two iodides which had previously been examined by Bödeker. CdI_2, in very beautiful pearly scales, gave 5·9857 at 12°, and 5·9738 at 13·5°. Bödeker's figure is 4·576 at 10°, making the salt *lighter* than either of the elements contained in it. This fact of itself would tend to throw suspicion upon Bödeker's results.

Bismuth iodide, BiI_3, gave Mr. Fullerton 5·9225 at 16°, and 5·8813 at 17·5°. Bödeker found 5·652 at 10°. Here again I regard Mr. Fullerton's figures as the more trustworthy.

The following double and compound cyanides were determined by Mr. W. L. Dudley.

Nickel potassium cyanide, K_2NiCy_4, H_2O; 1·875, 11°; and 1·871, 14·5°.

Potassium platinocyanide, $K_2PtCy_4, 3H_2O$, slightly moist, 2·5241, 13°, and 2·4548, 16°. The discrepancy between the two is undoubtedly due to the moisture which could not easily be removed.

Ammonium sulphocyanide, NH_4CyS, 1·299 and 1·316 at 13°.

Potassio-chromic sulphocyanide, $K_6CrCy_{12}S_{12}, 8H_2O$, 1·7051, 17·5°; 1·7107, 16°.

Potassio-platinic sulphocyanide, $K_2PtCy_6S_6$, 2·370, 19°, and 2·342, 18°.

Sodium nitroprusside, 1·6869, 25°. Schröder found 1·710 and 1·716 for this salt.

Four nitrates were determined by Mr. H. Laws.

$NiN_2O_6, 6H_2O$, gave 2·065, 14°, and 2·037, 22°.
$ZnN_2O_6, 6H_2O$, gave 2·063, 13°, and 2·067, 15°.
$CdN_2O_6, 4H_2O$, gave 2·450, 14°, and 2·460, 20°.
$BiN_3O_9, 5H_2O$, well crystallized, gave 2·823 at 13°.

This salt has also been determined by Playfair and Joule, who found 2·736. Their method of working, however, was less reliable than that with the specific gravity bottle.

The bromates were taken up by Miss E. D. Storer, with the following results.

$KBrO_3$, 3·323 at 19°. Kremers found 3·271, and Topsoë 3·218. The agreement is tolerable.

$AgBrO_3$, 5·1983, 16°, and 5·2153, 18°.

$BaBr_2O_6$, carefully dehydrated, 4·0395, 17°, 3·9918, 18°.

Hyposulphites, measured by Mr. L. T. Richardson.

CaS_2O_3, $6H_2O$, in fine crystals, 1·8715, 13·5°, and 1·8728, 16°.
SrS_2O_3, $6H_2O$, in good crystals, 2·1566, 2·1991, both at 17°.
BaS_2O_3, H_2O, precipitated, 3·4461, 16° and 3·4486, 18°.

Mr. Richardson also made a determination for potassium sulphate, getting 2·653, 18°. This agrees closely with Pettersson's figure, 2·66.

Tungstates, examined by Mr. J. L. Davis. The sodium salt was a commercial product, and was therefore first analyzed to be certain of its character. The nickel and barium salts were prepared by the well-known method of fusion.

Na_2WO_4, 4·1743, 20·5°, and 4·1833, 18·5°.
Na_2WO_4, $2H_2O$, 3·2588, 17·5°, and 3·2314, 19°.
$BaWO_4$, 5·0035, 13·5°, and 5·0422, 15°.
$NiWO_4$, 6·8846, 20·5°, and 6·8522, 22°.

Molybdates, prepared and determined by Mr. F. O. Marsh.

$BaMoO_4$, 4·6589, 17·5°, and 4·6483, 19·5°.
$SrMo_4$, 4·1554, 20·5°, and 4·1348, 21°.

Mr. C. A. Mohr worked upon phosphates and hypophosphites, as follows.

Barium hypophosphite, $BaP_2H_4O_4$, H_2O, 2·8718, 10°, and 2·8971, 17°.

Magnesium hypophosphite, $MgP_2H_4O_4$, $6H_2O$, 1·5886, 12·5°, and 1·5681, 14·5°.

Sodium metaphosphate, $NaPO_3$, prepared by igniting microcosmic salt, 2·4756, 19·5°, and 2·4769, 18°.

Potassium metaphosphate, KPO_3, prepared by igniting the monopotassium ortho-salt, 2·2639, and 2·2513, both at 14·5°.

No other hypophosphites or metaphosphates have as yet had their densities determined.

Trisodium orthophosphate, anhydrous, Na_3PO_4, 2·5111, 12°; 2·5362, 17·5.

Sodium pyrophosphate, $Na_4P_2O_7$, $10H_2O$, 1·7726, 21°. Playfair and Joule found 1·836.

The same salt, dehydrated by ignition, 2·3851 and 2·3613, 17°. Schröder's determination makes the salt 2·534, a widely different figure.

The following series of chromates was prepared and examined by Miss E. O. Abbot.

Magnesium chromate, $MgCrO_4$, $7H_2O$, finely crystallized, 1·7613 at 16°. For this salt Bödeker found 1·75, and Kopp 1·66. The higher result is more probable. In her work on this compound Miss Abbot also determined another important fact, namely that, like the corresponding sulphate, magnesium

chromate loses six molecules of water readily, holding the seventh with much greater firmness. Heated to 130° the salt loses 40·21 per cent of water, the theoretical quantity being for six molecules 40·52. Heated still hotter, say to 230°, more water, but not the whole, is expelled, the compound at the same time undergoing partial decomposition. The density of $MgCrO_4, H_2O$, was found to be 2·2886 and 2·2301, at 17°.

Ammonium chromate, $(NH_4)_2CrO_4$, crystallized, 1·9138 and 1·9203, 12°. Schröder makes it 1·860 to 1·871.

Ammonium dichromate, $(NH_4)_2Cr_2O_7$, 2·1223, 16°, and 2·1805, 17°. Schröder found 2·153; a close agreement.

Sodium chromate, Na_2CrO_4, 2·7358, 12°, and 2·7104, 16·5°. The decahydrated salt, $Na_2CrO_4, 10H_2O$, was also attempted, but with poor results. A single determination came out 1·4828 at 20°, a figure probably much too low. The difficulty in dealing with this body arises from the extreme instability of its water of crystallization.

Ammonium-magnesium chromate, $(NH_4)_2Mg(CrO_4)_2, 6H_2O$, well crystallized, 1·8278 and 1·8595 at 16°. Also 1·8293 at 17°. In preparing this compound, cold saturated solutions of the separate chromates were mixed. Instantly a heavy crystalline precipitate was formed, which dissolved up again upon heating. As the solution cooled, crystals were abundantly deposited. Evidently, then, the double salt is much less soluble than either of its components.

Potassium-magnesium chromate, $K_2Mg(CrO_4)_2, H_2O$, 2·5804, 19°; and 2·5966, 19·5°. Schröder gives 2·592 to 2·608, a close agreement.

These chromate determinations fill up some important gaps in this series of salts, and help us to arrive at some interesting conclusions. Pettersson has lately shown that selenates have molecular volumes exceeding those of the corresponding sulphates by 6 for each molecule of the acid radicle. Thus, the molecular volume of sodium selenate is that of the sulphate plus 6; that of a selenic alum exceeds that of the corresponding sulphuric alum by four times 6, and so on. Upon comparing these and other chromates with Pettersson's selenates we now find that the two series of salts have approximately equal molecular volumes; the difference, if any exists, being very slightly plus for the selenates. If regularities of this kind can be thoroughly established, it will be easy, having the density of a chromate, to calculate that of the corresponding sulphate or selenate, and *vice-versa*. This connection between chromates and selenates has already been suggested by Schröder, and Miss Abbot's figures do much towards confirming it. Miss Abbot has also redetermined the density of chromic chloride, Cr_2Cl_6, on a beautifully characterized specimen. She finds 2·3572, 17·5°, and 2·3766, 16·5°. Schafarik's figure for the substance

being 3·03, I redetermined it again in person, and got 2·349 at 20°. My result thus confirms those of Miss Abbot, and the question is raised whether this compound may not exist in more than one modification as regards density.

The following series of pyrophosphates was worked up by Mr. G. W. Lewis. They were prepared by igniting the double ammoniacal orthophosphates.

$Mn_2P_2O_7$, 3·5847, 20°, and 3·5742, 26°.
$Mg_2P_2O_7$, 2·598, 22°, and 2·559, 18°. Schröder found 2·22.
$Zn_2P_2O_7$, 3·7538 and 3·7574, 23°.
$Co_2P_2O_7$, 3·746, 23°, and 3·710, 25°.
$Ni_2P_2O_7$, 3·9303, 25°, and 3·9064, 27°.

Some of the corresponding pyroarsenates were prepared by Miss Helena Stallo, as follows.

$Mn_2As_2O_7$, 3·6832 and 3·6927, 23°. Also 3·6625, 25°.
$Zn_2As_2O_7$, 4·7034 and 4·6989, 21°.
$Mg_2As_2O_7$, 3·7305, 15°, and 3·7649, 18°.

Miss Stallo also determined the anhydrous trisodium orthoarsenate, getting 2·8128 and 2·8577, 21°.

The following compounds, representing various series, may be regarded as scattering.

Glucinum sulphate, $GlSO_4$, $4H_2O$, 1·6743, 22°, Miss Stallo. Topsoë found for this salt, 1·725. The sample Miss Stallo worked with was slightly damp, which will account for the difference.

Potassio-chromic oxalate, $CrK_3C_6O_{12}$, $3H_2O$; 2·1039, 23°, and 2·1464, 24°; E. P. Bishop.

Stannous chloride, $SnCl_2$, $2H_2O$, 2·634, 24°, E. P. Bishop. The published figure obtained by Penny was 2·71, 15·5°.

Cupro-mercuric iodide, $HgI_2 . CuI$, 6·1602, 15°, and 6·1412, 13°, A. E. Heighway.

Mercuric chloride with ammonium dichromate, $HgCl_2 . Am_2Cr_2O_7 . H_2O$, in large crystals, 3·2336, 21°, and 3·1850, 18°, A. E. Heighway.

Mercuric acetate, $Hg(C_2H_3O_2)_2$, 3·2544, 22°, and 3·2861, 23°, John Hagemann.

This completes the list of determinations thus far made by my students. Sixty-three compounds are here given, forty-six among them not having been measured before. In concluding, I will give a few determinations of my own.

Potassium iodate, KIO_3. There are two published values for this salt, namely, 3·979, Kremers, and 2·601, Ditte. These vary from each other so widely that I thought it worth while to redetermine the salt, and I obtained the figure 3·802, 18°. This confirms Kremers.

Tellurium dioxide, TeO_2, 5·7559, 12·5°, and 5·7841, 14°. Schafarik found 5·93.

Tellurium trioxide, TeO_3, 5·0704, 14·5°; 5·0794, 10·5°. Another sample gave 5·1118, 11°.

Barium tellurate, $BaTeO_4$, feebly ignited, 4·5486, 10·5°; 4·5305, 10°. Another sample gave 4·4811, 16°. This salt, like the sulphate, becomes much denser by ignition. Unignited, but dried at 200°, its specific gravity is in the neighborhood of 4·2.

VI. *An Analysis of Sylvanite from Colorado.*

Having had occasion lately to analyze a sylvanite from the Grand View Mine, Colorado, I publish the result here, not because it contains anything novel, but because it seems to be desirable that such material should be preserved for future reference and discussion. The ore from this mine has, I believe, not been carefully analyzed before. The specimen was imbedded in quartz, associated with a little iron pyrites, and had all the usual characteristics of sylvanite.

The analysis came out as follows, after eliminating a little gangue.

Tellurium	52·96
Gold	26·39
Silver	10·55
Iron	4·45
Sulphur	5·62
	99·97

The sulphur was not estimated directly, but was calculated as pyrites to correspond with the amount of iron found. Eliminating the pyrites the analysis will stand thus.

Tellurium	58·91
Gold	29·35
Silver	11·74
	100·00

This sylvanite was kindly given me by Professor E. S. Wayne, of Cincinnati.

ART. XXXIX.—*Notes on the Analysis of Bituminous Coal;* by T. O'CONOR SLOANE, A.M., E.M., Ph.D.

THE determination of ash in coal appears a very simple matter; yet I have on several occasions found much difficulty in reaching accurate results. I traced the error finally to insufficient pulverization of the coal.

A sample of coal was reduced to powder and passed through a fine wire sieve, number sixty, or eighty, mesh. I made a

number of determinations of ash, using different weights of the coal, and got the following widely discordant results:

a. From 3 grams, 6·66 p. c.; *b.* 12 grams, 3·72 p. c.; *c.* 1 gram, 4·67 p. c.; *d.* 2 grams, 4·40 p. c.; *e.* 12 grams, 2·63 p. c.

I then took all that was left of the pulverized coal, spread it out upon a piece of glazed cloth, and divided it into two parts, each of about the same weight. I did this with the usual precautions adopted in sampling, so that the coal in each half would be exactly the same. One of these parts was ignited and incinerated. Its weight was 23·9665 grams. The ash weighed ·9920 grams, or determination *f.* 24 grams nearly, 4·14 per cent. The other portion was powdered in a porcelain mortar until of a full brown color. The ash was determined in one gram of it, giving 3·90 per cent, *e.* 1 gram, 3·90 per cent.

I have since this investigation subjected any coal I was about to analyze to a fine powdering in a porcelain mortar. I am of opinion that it would be well to prolong the operation in an agate mortar, but the process is too tedious. Though the coal be reduced to a brown powder, it is still quite difficult to obtain good duplicate results. I give below some instances:

	1.	2.
Coal A.....	4·50 p. c.	4·00 p. c.
B.....	5·25	5·12
C.....	13·86	14·10
D.....	5·82	5·75

The ash I generally determine in one gram of the coal. If the crucible, in which the incineration is taking place be supported on the triangle in an inclined position, and if the lid be so placed as to direct the exterior zone of the flame into it, the operation will be greatly abridged. By looking into the crucible while over the burner it can be seen when the right position has been reached. The cake of coke will appear bright, or ignited, on the surface. From time to time it may be rubbed, or broken up if possible, with a platinum wire. Before incineration the sample should be ignited in the same crucible with the cover on.

The sulphur may be conveniently determined by fusion with the salt flux (Fresenius, Vacher's Ed., p. 127). One gram of the coal is fused with a mixture of NaCl 24 grams, $NaNO_3$ 8 grams, Na_2CO_3, 4 grams. Frequently a mixture of equal parts of nitrate, and carbonate of soda is employed, sixteen parts of the mixture to one part of coal. With the salt flux the reaction is less violent, all can be at once introduced into the crucible, and immediately fused. The coal mixed with the deflagrating flux, the second described, has, on the contrary, to be thrown into the hot crucible a little at a time, so that

it exacts more attention and trouble. The salt fusion, in two comparative determinations that I made, gave higher results on the same coal.

	Salt Fusion.	Deflagration.
Coal A	1·70 p. c.	1·37 p. c.
B	1·92	1·69

The specific gravity cannot be satisfactorily determined without the specific gravity bottle. By weighing lumps in air and in water all sorts of results will be obtained. I break up a sample in an iron mortar and pass it through a No. 4 or 6 sieve. I then shake it up in a finer, No. 15 or 20, sieve, so as to free it from the dust and fine particles. This seems a bad practice yet cannot well be avoided. The finely divided coal, if left in with the rest, will float on the surface of the water used in determining its specific gravity, and no amount of boiling will make it sink.

The coal thus prepared I place in a small beaker with some distilled water, and boil it. I then put the coal and water into the specific gravity flask, fill up with recently boiled distilled water, and cool it to about the temperature of the room. The last cooling is done in a beaker of water which is stirred once or twice, during the cooling, to make the water of uniform temperature. When the bottle and contents have attained this temperature, the bottle is carefully filled, the stopper put in, and the whole dried and weighed. The coal is then thrown out, the bottle filled with recently boiled distilled water, brought to the same temperature as before, and weighed. This careful reduction to one temperature is very important; by paying attention to it very close duplicates can be obtained.

The specific gravity of coal varies with the percentage of ash; yet the correspondence is not so perfect as to make the determination of the specific gravity a substitute for that of the latter constituent. As the degree of correspondence is a matter of some interest, I give below a number of parallel determinations of ash and specific gravity.

Specific gravity.	Ash.	Specific gravity.	Ash.
1·282	4·02 p. c.	1·327	7·23 p. c.
1·300	4·08	1·308	7·95
1·286	4·14	1·334	10·38
1·296	4·68	1·377	13·98
1·295	5·18	1·385	16·22
1·294	5·78		

Tracing Cloth instead of Glazed Paper.

For the purposes of sampling and pulverizing minerals, coals, fertilizers, &c., for analysis, glazed paper is generally

employed. This soon wears out. I have adopted ordinary draughtsman's tracing cloth in its place. This lasts indefinitely, is just as smooth, and is much to be recommended for these purposes. In the assay laboratory, paper, used for mixing the weighed ores with the fluxes, soon wears out. Here, also, I would suggest the use of tracing cloth.

Laboratory N. Y. Gas Light Co., New York, August, 1877.

ART. XL.—*A Preliminary Catalogue of the Reptiles, Fishes and Leptocardians of the Bermudas, with descriptions of four species of Fishes believed to be new;* by G. BROWN GOODE.

IN a previous paper* I enumerated seventy-four species of fishes collected in the Bermudas in 1872. Another visit to these islands during the past winter has enabled me, with the coöperation of Mr. J. Matthew Jones, who kindly allowed me the use of his collections and note books, to increase the number to one hundred and sixty-three. Of these one hundred and forty-eight have been sufficiently studied to enable me to give their names in this preliminary list. I hope at an early day to discuss the fishes of the Bermudas in a more extended paper. Since there is a peculiar interest in the chorological relations of the members of an insular fauna, I have in a general way designated the distribution of each species by the use of letters. W. indicates the West Indian province, U. the eastern coast of the United States north of Georgia, E. the Eastern Atlantic, including Madeira, the Canary Islands and the Mediterranean, and P. the Indo-Pacific waters. These however do not show faunal relations accurately, since in this way it is impossible to distinguish those species which are resident in any particular district from mere stragglers. Those species which are peculiar to Bermuda are marked "B." and are eight in number; two of these, with *Carassius auratus*, introduced, occupy the land-locked brackish marshes. Two species, *Eucinostomus Lefroyi* and *Haliperca phœbe*, occur only in Bermuda and Cuba. The Bermudian fauna shares with the West Indies one hundred and sixteen species (or seventy-nine per cent), of which fifty-eight (or forty per cent) are peculiar to the West Indies, never having been recorded elsewhere, while a large number of others have their centers of distribution in that region, individuals having made their way in summer to the

* Catalogue of the Fishes of the Bermudas, based chiefly upon the collections of the United States National Museum. By G. Brown Goode, Assistant Curator U. S. National Museum. (Bulletin U. S. Nat. Mus., No. 5.) Washington: Government Printing Office. 82 pp. 8vo. 1876.

coasts of the United States or Europe. With the eastern United States, Bermuda shares forty-seven species, five of which are otherwise recorded only from our waters, all of these, viz: *Ceratacanthus aurantiacus*, *Zonichthys fasciatus*, *Lagodon rhomboides*, *Synodus fœtens*, and *Eulamia obscura*, will doubtless prove to be members of the West Indian fauna, and be found to occur in the islands adjoining the coast of Florida. With the waters of the Pacific and Indian Oceans, it has in common thirty-two species. Should *Glyphidodon cœlestinus* Solander, prove identical with *G. saxatilis*, another species will be added to this list.

The following are the numbers of species common to two or more faunas, the letters having significations as explained above:—B. W. U., 37; B. W. E., 36; B. W. P., 25; B. P. E, 22; B. U. E., 21; B. W. U. P., 3; B. W. U. E., 6; B. W. E. P., 7; B. W. U. P. E., 12.

The reptiles, it will be observed, are all pelagic except the lizard, which is peculiar to Bermuda and most closely related to the West African species of the genus.

CATALOGUE.

Class, REPTILIA.

Order, *Lacertilia.*

Eumeces longirostris *Cope.* Lizard. B.

Order, *Testudinata.*

Sphargis coriacea *Rond.* Leather Back Turtle.
Thalassochelys caouana *L.* Loggerhead Turtle.
Eretmochelys imbricata *L.* Hawksbill Turtle.
Chelonia mydas *Schw.* Green Turtle.

Class, PISCES.

Sub-class, TELEOSTEI.

Order, *Pediculati.*

Pterophryne picta (*Val.*) *Goode.* Devil Fish. W.
Pterophryne principis (*Val.*) *Goode.* W.

Order, *Plectognathi.*

Orthagoriscus mola (*L.*) *Schn.* Sun Fish. P. E. W. U.
Paradiodon hystrix (*L.*) *Blkr.* Sea Hedgehog. P. E. W.
Diodon novem-maculatus *Cuv.* P. W.
Chilomycterus reticulatus (*L.*) *Bibron.* Sea Porcupine. E. W.
Tetrodon rostratus *Bloch.* E.
Chilichthys Spengleri (*Bloch*) *Goode.* Swallow. E. W.
Ostracium quadricorne *L.* Cow Fish. E. W.
Ostracium triquetrum *L.* Cuckold. W.
Lactophrys trigonus (*L.*) *Poey.* U. W.
Balistes capriscus *Gmel.* Turbot. P. E. W. U.
Balistes vetula *L.* Blue Turbot. W. U.
Canthidermis maculatus (*Gmel.*) *Blkr.* Ocean Turbot. P. E. W.
Canthorhinus occidentalis (*Gthr.*) *Goode.* W. U.
Canthorhinus setifer *Benn.* var. **beta.** P. E. W. U.
Alutarius scriptus (*Osbeck*) *Blkr.* P. E. W.
Ceratacanthus aurantiacus (*Mitch.*) *Gill.* B. U.

Order, *Lophobranchii.*

Hippocampus antiquorum *Leach.* Sea Horse. P. E. W.
Hippocampus guttulatus *Cuv.* Sea Horse.
Syngnathus Jonesii *Gthr.* B.

Order, *Hemibranchii.*

Centriscus scolopax *L.* E. U.
Fistularia serrata *Cuv.* P. U. B.
Aulostoma maculatum *Val.* Trumpet Fish. W.

Order, *Teleocephali.*

Rhomboidichthys lunatus (*L.*) *Gthr.* Plaice. W.
Rhomboidichthys ocellatus (*Agass.*) *Gthr.* W.
Hemirhombus aramaca (*Cuv.*) *Gthr.* W.
Hemirhombus soleæformis (*Agass.*) *Gthr.* W.
Lefroyia bermudensis *Jones.* B.
Brotula barbata (*Schn.*) *Cuv.* W.
Undetermined gadoid fish.
Blennius crinitus *C. & V.* W.
Blennius (species undetermined).
Blennius (species undetermined).
Blennius (species undetermined).
Labrosomus nuchipinnis (*Q. & G.*) *Gill.* E. W. U.
Salarias texilis *Q. & G.* W.
Gobius soporator *C. & V.* Molly Miller. E. W.
Dactylopterus volitans (*L.*) *Cuv.* Flying Gumard. E. W. U.
Scorpæna Plumieri *Schn.* Prickly Hind. W. U.
Scarus radians *Val.* Spanish Porgy. W.
Scarus Catesbyi *Lac.* W.
Pseudoscarus vetula (*Schn.*) *Gill.* Blumber. W.
Pseudoscarus quadrispinosus (*C. & V.*) *Guich.* Rainbow. W.
Pseudoscarus cœruleus (*Bloch*) *Gthr.* Gillingbore. W.
Pseudoscarus croicensis (*Bloch*) *Goode.* W.
Pseudoscarus psittacus (*L.*) *Gthr.* Parrot Fish. W.
? Pseudoscarus acutus *Poey.* Mud Belly. W.
Chœrojulis radiatus (*L.*) *Goode.* Blue Fish. W.
Chœrojulis bivittatus (*Bloch*) *Poey.* Slippery Dick. W.
Lachnolæmus falcatus (*L.*) *Val.* Hog Fish. W.
Harpe rufus (*L.*) *Gill.* Spanish Hog Fish; Spanish Lady Fish. E. W.
Julis bifasciatus (*Bloch*) *Gthr.* W.
Julis nitidissima *Goode,* (new species) 1. B.
Pomacentrus leucostictus *M. & T.* W.
Glyphidodon saxatilis *L.* Cow Pilot; Sergeant Major. E. W. U.
Eucinostomus gula (*C. & V.*) *Goode* Shad. W.
Eucinostomus Lefroyi *Goode.* Long Bone Shad. W.
Acanthurus nigricans (*L.*) *Gill.* Doctor Fish. W. U.
Sarothrodus bimaculatus (*Bloch*) *Poey.* Four-eyed Fish. W.
Sarothrodus capistratus (*L.*) *Poey.* W.
Holacanthus ciliaris (*L.*) *Lacep.* Angel Fish. W. U.
Holacanthus tricolor (*Bloch*) *Lacep.* Black Angel Fish. W.
Xiphias gladius *L.* Sword Fish. E. W. U.
Thyrsites prometheus (*C. & V.*) *Gthr.* Cat Fish. E.
Orcynus alliteratus (*Raf.*) *Gill.* Mackerel. E. P. W. U.
Orcynus thynnus (*L.*) E. U.
Auxis Rochei (*Risso*) *Gthr.* Frigate mackerel. E. P. W.
Decapterus punctatus (*Agass.*) *Gill.* Round Robin. W. U.
Trachurops crumenophthalmus (*Bloch*) *Gill.* Goggle-Eye. P. W. U.
Paratractus pisquetos (*C. & V.*) *Gill.* Jack. W. U.
Carangus (near C. falcatus). Gwelly.
Carangus carangus (*Bloch*) *C. & V.* P. E. W.
Carangus dentex (*Bloch*) *C. & V.* E. W.
Trachynotus ovatus (*L.*) *Gthr.* Alewife. P. E. W. U.

Trachynotus goreensis *C. & V.* E. W.
Naucrates ductor *L.* Pilot Fish. E. P. W. U.
Zonichthys fasciatus (*Bloch*) *Sw.* Bonito. U.
Seriola Dumerilii *Risso.* Bonito. E. P.
Coryphæna pelagica (*L.*) Risso. Dolphin. E.
Nomeus Gronovii (*Gmel.*) *Gthr.* P. E
Centrolophus (species undetermined). E.
Brama Rayi *Schn.* E.
Malacanthus Plumieri (*Bloch*) *C. & V.* Whiting. W.
Mulloides flavovittatus (*Poey*) *Gthr.* Goat Fish. W.
Hypeneus maculatus (*Bloch*) *Cuv.* Goat Fish W. U.
Holocentrum sogo *Bloch.* Squirrel. W. U.
Pareques acuminatus (*Schn.*) *Gill.* Cluck; Black Grunt. W.
Calamus megacephalus (*Sw.*) *Poey.* Goat's Head Porgy. W.
Calamus orbitarius *Poey.* Sheep's Head Porgy. W.
Sargus variegatus (*Lac.*) *Goode.* Bream. E.
Sargus argenteus *C. & V.* W.
Lagodon rhomboides, (*L.*) *Holbrook.* Spanish Porgy. U.
Pimelepterus Boscii *Lac.* Chub. E. U.
Pristipoma (species undetermined). Sailor's Choice.
Hæmylum capeuna (*Licht.*) *Goode.* White Grunt. W. U.
Hæmylum xanthopterum *C. & V.* Yellow Grunt. W.
Hæmylum macrostoma *Gthr.* Streaked Grunt. W.
Lutjanus caxis (*Schn.*) *Poey.* Gray Snapper. W.
Lutjanus buccanella (*C. & V.*). Black-Fin Red Snapper. W.
Lutjanus aya (*Bloch*) *Gill.* Red Snapper. W.
Lutjanus (species undetermined). Silk Snapper.
Lutjanus (species undetermined). Schoolmaster.
Ocyurus chrysurus (*Bloch*) *Gill.* Yellow Tail: Yelting. W.
Trisotropis undulosus (*Cuv.*) *Gill.* W.
var. quadratus *Goode,* MS. Black Rock Fish.
var. venatus *Goode,* MS. Geg.
var. rubromaculatus *Goode,* MS.
Trisotropis guttatus (*Schn.*) *Gill.* Red Rock Fish. W.
Trisotropis (species undetermined). Salmon Rock Fish. W.
Epinephelus striatus (*Bloch*) *Gill.* Hamlet; Grouper. W.
Epinephelus guttatus (*Gmel.*) *Goode.* Hind. W.
Enneacentrus punctatus (*L.*) *Poey.* E. W.
var. guativere *Goode,* MS. Coney; Butter Fish.
var. ouatalibi *Goode,* MS. Nigger Fish.
Petrometopon guttatus (*L.*) *Gill.* W.
Serranus (species undetermined). Graysby.
Serranus (species undetermined). Mutton Hamlet.
Haliperca phœbe *Poey.* Phebe. W.
Hypoplectrus puella (*Cuv.*) *Gill.* Cataphebe. W.
Rhypticus saponaceus (*Schn.*) *Cuv.* Soap Fish. E. W. U.
Undetermined percoid fish.
Elacate canadus (*L.*) *Gill.* Cubby-yew. P. E. W. U.
Apogon imberbis (*L.*) *Gthr.*
Priacanthus macrophthalmus *C. & V.* E. W. U.
Echeneis remora *L.* Suck Fish. P. E. W. U.
Leptecheneis naucrates (*L.*) *Gill.* Suck Fish. P. E. W U.
Sphyræna spet (*Hauy*) *Goode.* Barracuda. E.
Sphyræna picuda *Schn.* Sennet. E. W.
Regalecus gladius (*Walb.*) *C. & V.* Sea Serpent. E. P.
Mugil liza *Val.* Mullet. W.
Atherina harringtonensis *Goode,* (new species) 3. Russ Fry. B.
Belone Jonesii *Goode,* (new species) 2. Hound Fish. B.
Belone hians *C. & V.* Long Gar Fish. W.
Hemirhamphus Pleii *Val.* Gar Fish. W.
Exocœtus exiliens *Gmel.* Butterfly Fish. W. U.
Exocœtus bahiensis *Rana.* Flying Fish. P. W.

Exocœtus Roberti *M. & T.* Flying Fish. W.
Exocœtus Rondeletii *C. & V.* Flying Fish. E. W.
Cypselurus furcatus (*Mitch.*) *Weinl.* Flying Fish. P. W. U.
Fundulus Bermudæ *Gthr.* Pond Mullet. B.
Fundulus rhizophoræ *Goode*, (new species) 4. B.
Synodus lacerta *C. & V.* Snake Fish. E.
Synodus fœtens (*L.*) *Gill.* Snake Fish. U.
Trachinocephalus myops (*Schn.*) *Gill.* Snake Fish. P. U.
Albula conorhynchus *Schn.* Bone Fish. P. E. W. U.
Megalops thrissoides (*Schn.*) *Gthr.* Tarpum. W. U.
Sardinella anchovia *Val.* Anchovy. W.
Harengula macrophthalma (*Ranz.*) *Goode.* Pilchard. W.
Opisthonema thrissa (*L.*) *Gill.* Herring. W. U.
Engraulis chœrostomus *Goode.* Hog Mouth Fry. B.
Carassius auratus (*L.*) *Blkr.* Gold Fish.

Order, *Apodes.*

Anguilla rostrata (*Les.*) DeKay. Pond Eel. P. U.
Gymnothorax moringa (*Cuv.*) *Goode.* Speckled Maray. E. W.
Gymnothorax punctatus (*Cast.*) *Goode.* Small Yellow Spotted Maray. P.
Thyrsoidea maculipinnis *Kaup.* Green Maray. W.
Muræna Sanctæ-Helenæ, *Gthr.* E.
Echidna catenata (*Bloch*) *Blkr.* W.
Ophisurus longus *Poey.* Sand Eel. W.
Ophichthys triserialis (*Kaup.*) *Gthr.* Spotted Sand Eel. P. W.
Leptocephalus (species undetermined).

Sub-class, GANOIDEA.

Order, *Glaniostomi.*

Acipenser, sp. Sturgeon.

Sub-class, ELASMOBRANCHII.

Order, *Raiæ.*

Ætobatis narinari (*Euphr.*) *M. & H.* Whip Ray. P. W. U.

Order, *Squali.*

Isuropsis, sp. Mackerel Shark.
Sphyrna zygæna (*L.*) *M. & H.* Hammer-Head Shark. P. E. W. U.
Eulamia obscura (*Les.*) *Gill.* Shark. U.
Mustelus canis (*Mitch.*) *DeKay.* Nurse Shark. U.
Ginglymostoma cirratum (*Gmel.*) *M. & H.* W. U.
Curious form in collection of J. M. Jones, genus and species undetermined.

Class, LEPTOCARDII.

Order, *Cirrostomi.*

Branchiostoma lubricum *Costa.* P. E. W. U.

DESCRIPTIONS OF NEW SPECIES.

1. *Julis nitidissima*, sp. nov.

This species agrees in many particulars with that described by Dr. Gunther under the name *Julis nitida*, from Jamaican specimens in the British Museum.*. There are, however, various diagnostic characters which it seems desirable to express in the form of a description, at the same time designating the Bermuda fish by a distinct specific name which, by its similarity to that of the species which it so much resembles,

* Catalogue of Fishes in the British Museum, vol. iv, p. 190, 1862.

will indicate my suspicion that, upon comparison of the specimens, the two species may prove to be identical.

The fish is quite small, rarely exceeding three inches in length, and is very abundant among the outer reefs, swimming among the Gorgonias and Plexauras, six or eight fathoms below the surface, a very conspicuous object by reason of its brilliant yellow colors. It is extremely shy and it was only after repeated trials that I succeeded in capturing a single specimen, which took a small hook baited for chubs.

The diagnostic characters which separate *Julis nitida* from *Julis nitidissima* appear to consist in (1) the relative proportions of head and body, (2) the relative proportions of pectorals and ventral fins, (3) the number of rows of scales below lateral line, and (4) in the coloration. The latter character is, however, of minor importance, it being quite possible that a faded museum specimen of the fish before me might have assumed the colors described by Dr. Günther.

The specimen described is small, though apparently adult, its total length being about three and one-half inches (m. 0·103). The body is much compressed, its greatest width (m. 0·009) being about three-eighths of its greatest height (m. 0·023), which is contained in the total length about four and one half times. Length of head (m. 0·025) contained in total length four and one half times (in fresh specimen three and three-quarters, it having been contracted by preservation in spirits). No posterior canine teeth. Length of snout (m. 0·008) equal to length of operculum (m. 0·008) and to four-fifths of greatest width of head (m. 0·01). Width of interorbital area (m. 0·007) somewhat less. Orbit circular, its diameter (m. 0·005) equal to greatest height of dorsal.

Dorsal inserted slightly in advance of origin of ventral at a distance (m. 0·03) equal to three times the greatest width of the head, length of base (m. 0·027) slightly greater than length of head. Length of first dorsal spine (m. 0·004) half the length of snout; greatest height of spinous dorsal (m. 0·005) equal to diameter of orbit. Greatest height of soft dorsal (m. 0·008) double that of first dorsal spine.

Distance of anal from snout (m. 0·052) twice the length of head, which is about equal to length of anal base (m. 0·024). First anal spine (m. 0·003) half the length of second anal spine (m. 0·007) and one-third the length of longest ray (m. 0·01).

Caudal lobes slightly produced, their length (m. 0·016) two-thirds that of the head and twice that of the snout. Least height of tail (m. 0·012) equal to length of ventrals.

Pectoral inserted at a distance from the snout (m. 0·028) equal to the length of the base of the dorsal, its length (m. 0·021) slightly less than the greatest height of the body.

Ventrals inserted at a distance from the snout (m. 0·031) a trifle greater than the dorsal. Length (m. 0·012) three-sevenths of that of the pectorals, not two-thirds as in *Julis nitida*—the most important of the diagnostic characters.

Radial formula, D. viii, 13. A. ii, 11.

Number of scales in lateral line, 26; in transverse line, 2 : 9.

Coloration :—Top of head and back brilliant sulphur-yellow; this color, above the pectorals, extending to middle of row of scales beneath lateral line, also present upon cheeks, opercles, and lips, and to ventral fins. A semicircular spot of the same occupying the major part of the caudal fin, extending posteriorly quite to the margin. Throat, belly and sides of tail white with a rich, deep roseate tinge. A band of maroon, as wide as the eye, crossing the snout passes back through the eye nearly to the tip of the opercular flap. A series of six broad irregular blotches of bottle green, somewhat quadrate in outline, each covering about the width of four transvere rows of scales, extends from the opercle, above the pectorals and across the downward curve of the lateral line to the base of the caudal. The posterior blotch is prolonged upon the outer rays of the caudal to the tips forming a crescent shaped figure. Dorsal fin at margin transparent, white, at the base yellow, the intermediate space brownish green, deeper in shade anteriorly, and between the second and fifth ray, forming a blotch, similar to that indicated in the description of *Julis nitida*. Pectorals transparent. Anal rose color with yellow transparent margin. Ventrals yellow. Caudal, as hitherto described, yellow with exterior lobes brownish green.

2. *Belone Jonesii*, sp. nov.

The total length of the specimen selected as a type of the species is eighteen inches (m. 0·60).

The body is slightly compressed, its greatest height, above the ventrals (m. 0·03) one-twentieth of total length, its greatest width (m. 0·022) about one twenty-eighth of the same. Free portion of tail somewhat depressed, quadrate, its height (m. 0·01) one-third of greatest height of body. Caudal carinæ moderate.

Length of head (m. 0·196) contained about three and two-fifths times in total length, and about three and one-fourth of length without caudal. Upper surface of head somewhat depressed, striated, with a broad shallow median groove, which expands posteriorly into a wide, somewhat depressed triangular area. Superciliary region sharply striated.

Length of snout (m. 0·12) equal to length of maxillary (m. 0·12), contained five times in total length, and containing post-orbital length of head (m. 0·04) thrice. Length of mandible (m. 0·14) slightly less than distance from snout to nape (m.

0·157) and ten times the vertical diameter of the eyes (m. 0·014). Lower jaw projects four millimeters beyond the tip of upper jaw. Horizontal diameter of eye (m. 0·019) equal to width of interorbital area (m. 0·019) and to length of operculum (m. 0·019) and about one-eighth of length of head.

Teeth large, sharp, not very close. Maxillary teeth about sixty, the largest three millimeters in length; mandibular teeth about sixty, the largest two millimeters in length. Vomerine teeth none.

Distances from insertion of dorsal to snout (m. 0·433) slightly greater than that of anal (m. 0·431). Length of dorsal (m. 0·097) equal to distance from insertion of dorsal to insertion of ventral. Greatest height of dorsal (m. 0·026) equal to greatest width of head (m. 0·025).

Anterior rays longest, their length (m. 0·03) one-tenth of distance from ventral to snout. Length of last ray (m. 0·013) about one-third of that of anterior rays.

Length of anal (m. 0·085) less than that of dorsal. Posterior rays half the length (m. 0·007) of posterior dorsal ray. Anal fin terminating anteriorly to dorsal at a distance equal to length of first dorsal ray.

Ventrals inserted at distance from snout (m. 0·34) greater than half the length of body, and midway between anterior margin of orbit and base of median caudal rays. Length (m. 0·028) slightly exceeding greatest width of head.

Pectoral inserted at distance from snout (m. 0·191) equal to ten times width of interorbital space; its length (m. 0·045) slightly exceeding postorbital length of head.

Caudal forked, the length of inferior rays (m. 0·053) exceeding that of superior rays (m. 0·04) by about the length of median rays (m. 0 012).

Radial formula—D, 9 + 14 : A, 14 + 7 : C, 5 + 10—9 + 6 : P, 13 : V, 5.

Branchiostegals, 12.

Number of scales in lateral line (estimated), 380.

Coloration:—Above deep green, below silvery white, opercles and cheeks silvery white. Anterior rays of dorsal and pectoral fins, with caudal carinæ blackish.

I take great pleasure in giving to this species the name of my friend Mr. J. Matthew Jones, F.L.S., President of the Nova Scotian Institute of Natural Sciences, who has for two winters been associated with me in the study of the Bermudian fauna.

The "Hound Fish," as it is called in Bermuda, is a graceful, active species, attains the length of three feet or more. It frequents swift tide courses where it preys upon small fishes, particularly the schools of *Atherina* and *Engraulis*. It takes the hook well.

3. *Atherina Harringtonensis*, sp. nov.

The length of the specimen selected as type of the species is one and one-half inches (m. 0·055), the measurement being that of a specimen which has been in strong alcohol for four months. From the discrepancy between this measurement and a partial set of measurements taken from a fresh specimen of the same species I infer that the shrinkage in the length of the body has been quite considerable, probably from six to eight millimeters. The proportions given below are taken from the alcoholic specimen. In the study of fresh specimens allowance should be made for discrepancies caused by this shrinkage. The proportions of the head do not appear to have been changed by the alcohol.

The height of body (m. 0·07) is contained in length about eight times (8½ in fresh specimen), its width about twice in its height.

Length of head (m. 0·011) about equal to length of caudal peduncle (m. 0·01) and contained five times in total length (5¼ in fresh specimen).

Diameter of eye (m. 0·004) about one-third the length of head, the length of snout somewhat less than that of post-orbital portion of head, also equal to length of maxillary, and slightly greater than width of inter-orbital area (m. 0·0037). Greatest width of head (m. 0·006) about double the length of snout. Length of mandible (m. 0·005) about equal to that of post-orbital portion of head. Cleft of mouth quite oblique, maxillary extending to the vertical from anterior margin of orbit. Lower jaw slightly the longer; mouth very protractile; teeth small, inconspicuous.

Spinous dorsal inserted behind extremity of ventral, at a distance from snout (m. 0·03) greater here than half the length of body. Anal directly beneath dorsal, their lengths of base (m. 0·007) being equal. Greatest height of anal (m. 0·005) greater than that of dorsal (m. 0·003).

Length of ventral (m. 0·006) two-thirds that of pectoral (m. 0·009) which exceeds three-fourths that of head.

Radial formula:—D. VII, I, 10: A. I, 11.

Number of scales in lateral line about forty-five; in transverse line about six.

Coloration:—Greenish white, a narrow silvery band extending from gill-opening to tail, covering the third row (from above) of scales and the edges of the contiguous rows above and below.

The "Russ Fry" occurs in immense quantities in all the lagoons and protected bays of the Bermudas. The schools swim near the surface of the water and are preyed upon by all the carnivorous species. They are particularly abundant in the beautiful little lagoon called Harrington Sound.

4. *Fundulus rhizophoræ*, sp. nov.

The length of the specimen selected as type is six centimeters. Height of body at insertion of pectorals (m. 0·015) one-fourth of total length, at ventral (m. 0·009) about one seventh, at base of caudal (m. 0·0075) one-eighth.

Head much depressed, its length (m. 0·017) contained three and one-eighth in total. Snout broad, obtuse, depressed, its length (m. 0·006) slightly longer than orbital diameter and contained in length of head about three times. Inter-orbital area broad and flat, its width (m. 0·007) less than length of post-orbital portion of head (m. 0·009) and greater than length of operculum (m. 0·006). Diameter of orbit (m. 0·0045) half the length of post-orbital tract.

Origin of dorsal fin equidistant from tip of caudal and anterior margin of snout, and over the eighteenth scale of lateral line. Distance from snout (m. 0·018) three-tenths of total length; extreme height (m. 0·006) one-tenth, and length of base (m. 0·008) two-fifteenths.

First anal ray below third dorsal ray; length of base (m. 0·005) one-twelfth of total length. Extreme height (m. 0·011) double length of base, and nearly double the extreme height of dorsal.

Ventral inserted slightly in advance of middle of body (distance from snout, m. 0·029), its length (m. 0·007) equal to width of inter-orbital area.

Pectoral inserted at distance from snout (m. 0·02) equal to one-third of total length; length (m. 0·009) equal to post-orbital length of head.

Length of caudal (m. 0·01) equal to height of anal and about one-sixth of total.

Radial formula:—D. 12 : A. 11.

Number of scales in lateral line thirty-five; rows in transverse line twelve or thirteen.

Coloration:—Ground color light tawny yellow with about fifteen regular transverse bands of greenish brown, each about two scales in width, obscure anteriorly but distinct upon posterior half of body.

This little minnow occurs abundantly in Basden Pond, a brackish marshy body of water at the eastern end of the main island, among the arching roots of the mangrove (*Rhizophora mangle*). It is known as the "Pond Mullet," but may more appropriately be called the Mangrove Minnow. The specimens described are young males, not in breeding colors.

ART. XLI.—*History of Cavern Exploration in Devonshire, England;* by W. PENGELLY, F.R.S., F.G.S., President of the Geological Section of the British Association at Plymouth.

* * * * AMONG the local geological papers read [before the British Association] in 1841 [at the time of its only previous visit to Plymouth,] none appear to have attracted so much attention as those on Lithodomous Perforations, Raised Beaches, Submerged Forests, and Caverns (see Athenæum for 7th to 28th of August, 1841); and, as an effort to connect the present with the past, I have decided on taking up one of these threads. and devoting the remarks I have now to offer to the History of Cavern-Exploration in Devonsire. I am not unmindful that there were giants in those days; and no one can deplore more than I do our loss of Buckland and De la Beche, among many others; nor can I forget the enormous strides opinion has made since 1841, when, in this Section, Dr. Buckland "contended that human remains had never been found under such circumstances as to prove their contemporaneous existence with the hyænas and bears of the caverns," and added that "in Kent's Hole the Celtic knives * * * * were found in holes *dug by art*, and which had disturbed the floor of the cave and the bones below it" (Athenæum, 14th Aug., 1841, p. 626). This scepticism, however, did the good service of inducing cavern explorers to conduct their researches with an accuracy which should place their results, whatever they might prove to be, amongst the undoubted additions to human knowledge.

The principal caverns in South Devon occur in the limestone districts of Plymouth, Yealmpton, Brixham, Torquay, Buckfastleigh, and Chudleigh; but as those in the last two localities have yielded nothing of importance to the anthropologist or the paleontologist, they will not be further noticed on this occasion. In dealing with the others it seems most simple to follow mainly the order of chronology; that is to say, to commence with the cavern which first caught scientific attention, and, having finished all that the time at my disposal will allow me to say about it, but not before, to proceed to the next, in the order thus defined; and so on through the series.

Oreston Caverns.—When Mr. Whidbey engaged to superintend the construction of the Plymouth Breakwater, Sir Joseph Banks, President of the Royal Society, requested him to examine narrowly any caverns he might meet with in the limestone-rock to be qarried a Oreston, near the mouth of the river Plym, not more than two miles from the room in which we are assembled, and have the bones or any other fossil remains that were met with carefully preserved (see Phil. Trans., 1817, pp.

176–182). This request was cheerfully complied with, and Mr. Whidbey had the pleasure of discovering bone-caves in November, 1816, November, 1820, August and November, 1822, and of sending the remains found in them to the Royal Society.

It is, perhaps, worthy of remark that, though cavern-researches received a great impulse from the discoveries in Kirkdale, Yorkshire, and especially from Dr. Buckland's well-known and graphic descriptions of them, such researches had originated many years before. The request by Sir Joseph Banks was made at least as early as 1812 (see Trans. Devon. Assoc., v, pp. 252, 253), and a paper on the Oreston discoveries was read to the Royal Society in February, 1817, whereas the Kirkdale Cavern was not discovered until 1821. British cave-hunting appears to have been a science of Devonshire birth.

The Oreston Caverns soon attracted a considerable number of able observers; they were visited in 1822 by Dr. Buckland and Mr. Warburton; and in a comparatively short time became the theme of a somewhat voluminous literature. Nothing of importance, however, seems to have been met with from 1822 until 1858, when another cavern, containing a large number of bones, was broken into. Unfortunately, there was no one at hand to superintend the exhumation of the specimens; the work was left entirely to the common workmen, and was badly done; many of the remains were dispersed beyond recovery; the matrix in which they were buried was never adequately examined; and we are utterly ignorant, and must for ever remain so, as to whether they did or did not contain indications of human existence. I visited the spot from time to time, and bought up everything to be met with; but other scientific work in another part of the county occupied me too closely to allow more than an occasional visit. The greater part of the specimens I secured were lodged in the British Museum, where they seem to have been forgotten, while a few remain in my private collection.

Some difference of opinion has existed respecting the character of the successive caverns, and much mystery has been imported into the question of the introduction of their contents. Mr. Whidbey, it is said, "saw no possibility of the cavern of 1816 having had any external communication through the rock in which it was inclosed" (Phil. Trans., 1817, pp. 176–182); but Dr. Buckland was of opinion that they were all at first fissures open at the top, and "that the openings had been long filled up with rubbish, mud, stalactite, or fragments of rock cemented, as sometimes happens, into a breccia as solid as the original rock, and overgrown with grass" (Phil. Trans., 1822, pp. 171–240).

The conclusion I arrived at, after studying so much of the roof of the cavern of 1858 as remained intact, was that Dr. Buckland's opinion was fully borne out by the facts; that, in short, the Oreston Caverns were *Fissure Caverns*, not *Tunnel Caverns*.

The cavern of 1858 was an almost vertical fissure, extending a length of about ninty feet from N.N.E. to S.S.W. It commenced at about eight feet below the surface of the plateau, continued thence to the base of the cliff, but how much farther was not known, and its ascertained height was about fifty-two feet. It was two feet wide at top, whence it gradually widened to ten feet at bottom. The roof, judging from that part which had not been destroyed, was a mass of limestone-breccia, made up of large angular fragments cemented with carbonate of lime, and requiring to be blasted as much as ordinary limestone. The cavern was completely filled with deposits of various kinds.

The uppermost eight feet consisted of loose angular pieces of limestone, none of which exceeded ten pounds in weight, mixed with a comparatively small amount of such sand as is common in dolomitic limestone districts, but without a trace of stalagmite or fossil of any kind. The thirty-two feet next below were occupied with similar materials, with the addition of a considerable quantity of tough, dark, unctuous clay. Between this mass and the outer wall of the cavern was a nearly vertical plate of stalagmite, usually about two feet thick, and containing, at by no means wide intervals, firmly cemented masses of breccia identical in composition with the adjacent bed just mentioned. The bones the cavern yielded were all found within these thirty-two feet; and were met with equally in the loose and the coherent breccia, as well as in the stalagmite. A somewhat considerable number of ellipsoidal balls of clay, from 1·5 to 2·5 inches in greatest diameter, occurred in the clay of this bone-bed, but not elsewhere. Still lower was a mass of dark, tough, unctuous clay, containing a very few, small, angular stones, but otherwise perfectly homogeneous, and known to be twelve feet deep, but how much more was undetermined.

The osseous remains found at Oreston prior to 1858 have been described by Sir E. Home, Mr. Clift, Dr. Buckland, Professor Owen, Mr. Busk, and others. The animals represented were *Ursus priscus*, *U. spelæus*, weasel (?), wolf, fox, cave hyæna, cave lion, *Rhinoceros leptorhinus*, *Equus fossilis*, *E. plicidens*, *Asinus fossilis*, *Bison minor*, *Bos longifrons*, and, according to the late Mr. Bellamy, mammoth and hippopotamus (see Nat. Hist. of S. Devon, 1839, p. 82). With regard to hippopotamus, I can only say that I have never met with satisfactory evidence of its occurrence in Devonshire; but the

mammoth was certainly found at Oreston in 1858; and, unless I am greatly in error, remains of *Rhinoceros tichorhinus* were also met with there, and lodged by me in the British Museum. It may be added that the skull and other relics of a hog were exhumed on that occasion, and now belong to my collection. There was nothing to suggest that the cavern had been the home of the hyæna; and whilst I fully accept Dr. Buckland's opinion that animals had fallen into the open fissures and there perished, and that the remains had subsequently been washed thence into the lower vaultings ("Reliq. Dil.," 2d ed., 1834, p. 78), I venture to add that some of the animals may have retired thither to die; a few may have been dragged or pursued there by beasts of prey; whilst rains, such as are not quite unknown in Devonshire in the present day, probably washed in some of the bones of such as died near at hand on the adjacent plateau. Nothing appears to have been met with suggestive of human visits.

Kent's Hole.—About a mile due east from Torquay harbor and half a mile north from Torbay there is a small wooded limestone hill, the eastern side of which is, for the uppermost thirty feet, a vertical cliff, having at its base, and fifty-four feet apart, two apertures leading into one and the same vast cavity in the interior of the hill, known as Kent's Hole or Cavern. These openings are about 200 feet above mean sea-level, and from them the hill slopes rapidly to the valley at its foot, at a level of from sixty to seventy feet below.

There seems to be neither record nor tradition of the discovery of the cavern. Richardson, in the 8th edition of "A Tour through the Island of Great Britain," published in 1778, speaks of it as "perhaps the greatest natural curiosity" in the county. Its name occurs on a map dated 1769; it is mentioned in a lease 1659; visitors cut their names and dates on the stalagmite from 1571 down to the present century; judging from numerous objects found on the floor, it was visited by man through mediæval back to pre-Roman times; and, unless the facts exhumed by explorers have been misinterpreted, it was a human home during the era of the mammoth and his contemporaries.

In 1824 Mr. Northmore, of Cleve, near Exeter, was led to make a few diggings in the cavern, and was the first to find fossil bones there. He was soon followed by Mr. (now Sir) W. C. Trevelyan, who not only found bones, but had a plate of them engraved. In 1825, the Rev. J. MacEnery, an Irish Roman Catholic priest residing in the family of Mr. Cary, of Tor Abby, Torquay, first visited the cavern, when he, too, found teeth and bones, of which he published a plate. Soon after, be made another visit, accompanied by Dr. Buckland,

when he had the good fortune to discover a flint implement; the first instance, he tells us, of such a relic being noticed in any cavern (see Trans. Devon. Assoc., iii, p. 441). Before the close of 1825, he commenced a series of more or less systematic diggings, and continued them until, and perhaps after, the summer of 1829 (ibid., p. 295). Preparations appear to have been made to publish the results of his labors; a prospectus was issued, numerous plates were lithographed, it was generally believed that the MS. was almost ready, and the only thing needed was a list of subscribers sufficient to justify publication, when, alas! on February 18, 1841, before the printer had received any "copy," before even the world of science had accepted his anthropological discoveries, before the value of his labors was known to more than a very few, Mr. MacEnery died at Torquay.

After his decease his MS. could not be discovered, and its loss was duly deplored. Nevertheless, it was found after several years, and, having undergone varieties of fortune, became the property of Mr. Vivian, of Torquay, who, having published portions of it in 1859, presented it in 1867 to the Torquay Natural History Society, whose property it still remains. In 1869 I had the pleasure of printing the whole, in the Transactions of the Devonshire Association.

Whilst Mr. MacEnery was conducting his researches, a few independent diggings, on a less extensive scale, were taken by other gentlemen. The principal of these was Mr. Godwin-Austen, the well-known geologist, whose papers fully bore out all that MacEnery had stated. (See Trans. Geol. Soc. Lond., 2d series, vi, 446). In 1846, a sub-committee of the Torquay Natural History Society undertook the careful exploration of very small parts of the cavern, and their report was entirely confirmatory of the statements of their predecessor—that undoubted flint implements did occur, mixed with the remains of extinct mammals, in the cave-earth, beneath a thick floor of stalagmite. The sceptical position of the authorities in geological science remained unaffected, however, until 1858, when the discovery and systematic exploration of a comparatively small virgin cavern on Windmill Hill, at Brixham, led to a sudden and complete revolution; for it was seen that whatever were the facts elsewhere, there had undoubtedly been found at Brixham flint implements commingled with remains of the mammoth and his companions, and in such a way as to render it impossible to doubt that man occupied Devonshire before the extinction of the cave mammals.

Under the feeling that the statements made by MacEnery and his followers respecting Kent's Hole were perhaps, after all, to be accepted as verities, the British Association, in 1864, ap-

pointed a committee to make a complete, systematic, and accurate exploration of the cavern, in which it was known that very extensive portions remained entirely intact. This committee commenced its labors on March 28, 1865; it has been re-appointed, year after year, with sufficient grants of money, up to the present time; the work has gone on continuously throughout the entire thirteen years; and the result has been, not only a complete confirmation of Mr. MacEnery's statements, but the discovery of far older deposits than he suspected—deposits implying great changes of, at least, local geographical conditions; changes in the fauna of the district; and yielding evidence of men more ancient and far ruder than even those who made the oldest flint tools found in Kent's Hole prior to the appointment of the committee.

The cavern consists of a series of chambers and passages, which resolve themselves into two main *divisions*, extending from nearly north to south in parallel lines, but passing into each other near their extremities, and throwing off branches, occasionally of considerable size.

The successive deposits, in descending order, were:—

1st, or uppermost. Fragments and blocks of limestone from an ounce to upwards of 100 tons weight each, which had fallen from the roof from time to time, and were, in some instances, cemented with carbonate of lime.

2d. Beneath and between these blocks lay a dark-colored mud or mould, consisting largely of decayed leaves and other vegetable matter. It was from three to twelve inches thick, and known as the *black mould*. This occupied the entire eastern division, with the exception of a small chamber in its south-western end only, but was not found in the other, the remoter, parts of the cavern.

3d. Under this was a stalagmitic floor, commonly of granular texture, and frequently laminated, from less than an inch to fully five feet in thickness, and termed the *granular stalagmite*.

4th. An almost black layer, about four inches thick, composed mainly of small fragments of charred wood, and distinguished as the *black band*, occupied an area of about 100 square feet, immediately under the granular stalagmite, and, at the nearest point, not more than twenty-two feet from one of the entrances to the cavern. Nothing of the kind has occurred elsewhere.

5th. Immediately under the granular stalagmite and the black band lay a light red clay, containing usually about fifty per cent of small angular fragments of limestone, and somewhat numerous blocks of the same rock as large as those lying on the black mould. In this deposit, known as the *cave-earth*, many of the stones and bones were, at all depths, invested with

thin stalagmitic films. The cave-earth was of unknown depth near the entrances, where its base had never been reached; but in the remoter parts of the cavern it did not usually exceed a foot, and in a few localities it "thinned out" entirely.

6th. Beneath the cave-earth there was usually found a floor of stalagmite having a crystalline texture, and termed on that account the *crystalline stalagmite.* It was commonly thicker than the granular floor, and in one instance but little short of twelve feet.

7th. Below the whole occurred, so far as is at present known, the oldest of the cavern deposits. It was composed of subangular and rounded pieces of dark-red grit, embedded in a sandy paste of the same color. Small angular fragments of limestone, and investing films of stalagmite, both prevalent in the cave-earth, were extremely rare. Large blocks of limestone were occasionally met with; and the deposit, to which the name of *breccia* was given, was of a depth exceeding that to which the exploration has yet been carried.

Except in a very few small branches, the bottom of the cavern has nowhere been reached. In the cases in which there was no cave-earth, the granular stalagmite rested immediately on the crystalline; and where the crystalline stalagmite was not present the cave-earth and breccia were in direct contact. Large isolated masses of the crystalline stalagmite, as well as concreted lumps of the breccia, were occasionally met with in the cave-earth, thus showing that the older deposits had, in portions of the cavern, been partially broken up, dislodged, and re-deposited. No instance was met with of the incorporation in a lower bed of fragments derived from an upper one. In short, wherever all the deposits were found in one and the same vertical section, the order of superposition was clear and invariable; and elsewhere the succession, though defective, was never transgressed.

Excepting the overlying blocks of limestone, of course, all the deposits contained remains of animals, which, however, were not abundant in the stalagmites.

The black mould, the uppermost bed, yielded teeth and bones of man, dog, fox, badger, brown bear, *Bos longifrons*, roe-deer, sheep, goat, pig, hare, rabbit and seal—species still existing, and almost all of them in Devonshire. This has been called the *Ovine* bed, the remains of sheep being restricted to it. In it were also found numerous flint flakes and "strike-lights," stone spindle-whorls, fragments of curvilineal pieces of slate, amber beads, bone tools, including awls, chisels and combs; bronze articles, such as rings, a fibula, a spoon, a spear-head, a socketed celt, and a pin; pieces of smelted copper, and a great

number and variety of potsherds, including fragments of Samian ware.

The granular stalagmite, black band, and cave-earth, taken together as belonging to one and the same biological period, may be termed the *Hyænine* beds, the cave hyæna being their most prevalent species, and found in them alone. So far as they have been identified, the remains belong to the cave hyæna, *Equus caballus*, *Rhinoceros tichorhinus*, gigantic Irish deer, *Bos primigenius*, *Bison priscus*, red deer, mammoth, badger, cave bear, grizzly bear, brown bear, cave lion, wolf, fox, reindeer, beaver, glutton, *Machairodus latidens*, and man—the last being a part of a jaw with teeth, in the granular stalagmite. In the same beds were found unpolished *ovate* and *lanceolate* implements made from *flakes*, not *nodules*, of flint and chert; flint flakes, chips, and "cores;" "whetstones," a "hammer-stone," "dead" shells of *Pecten*, bits of charcoal, and bone tools, including a needle or bodkin having a well-formed eye, a pin, an awl, three harpoons, and a perforated tooth of badger. The artificial objects, of both bone and stone, were found at all depths in each of the hyænine beds, but were much more numerous below the stalagmite than in it.

The relics found in the crystalline stalagmite and the breccia, in some places extremely abundant, were almost exclusively those of bear, the only exceptions being a very few remains of cave line and fox. Hence these have been termed the *Ursine* beds. It will be remembered that teeth and bones of bear were also met with in both the hyænine and the ovine beds; and it should be understood that this biological classification is intended to apply to Kent's Cavern only. The ursine deposits, or rather the breccia, the lowest of them, also yielded evidences of human existence; but they were exclusively tools made from *nodules*, not *flakes*, of flint and chert.

Ansty's-Cove Cavern.—About three furlongs from Kent's Hole toward N.N.E., near the top of the lofty cliff forming the northern boundary of the beautiful Ansty's Cove, Torquay, there is a cavern where, simultaneously with those in Kent's Cavern, Mr. MacEnery conducted some researches, of which he has left a brief account (see Trans. Devon. Assoc., vi, pp. 61–69). I have visited it several times, but it seems to be frequently kept under lock and key, as a tool and powder-house, by the workmen in a neighboring quarry. It is a simple gallery, and, according to Mr. MacEnery, sixty-three feet long, from three to nine feet high, and from three to six feet broad. Beneath some angular stones he found a stalagmitic floor fourteen inches thick, and in the deposit below remains of deer, horse, bear, fox, hyæna (?), coprolites, a few marine and land shells, one white flint tool with fragments of others, a Roman coin, and potsherds.

In a letter to Sir W. C. Trevelyan, dated December 16th, 1825, Dr. Buckland states that Mr. MacEnery had found in this cave "bones of all sorts of beasts, and also flint knives and Roman coins; in short, an open-mouthed cave, which has been inhabited by animals of all kinds, quadruped and biped, in all successive generations, and who have all deposited their exuviæ one upon another" (ibid., p. 69).

Yealm-Bridge Cavern.—About the year 1832 the workmen broke into a bone-cavern in Yealm-Bridge Quarry, about one mile from the village of Yealmpton, and eight miles E.S.E. from Plymouth; and through their operations it was so nearly destroyed that but a small arm of it remained in 1835, when it was visited by Mr. J. C. Bellamy, who at once wrote an account of it, from which it appears that, so far as he could learn, the cavern was about thirty feet below the original limestone surface, and was filled to from one foot to six feet of the roof (see "Nat. Hist. S. Devon.," 1839, pp. 86–105). In the same year, but subsequently, it was examined by Capt. (afterwards Col.) Mudge, who states that there were originally three openings into the cave, each about twelve feet above the river Yealm; that the deposits were, in descending order:—

1.	Loam with bones and stones	3·5 feet.
2.	Stiff whitish clay	2·5 "
3.	Sand	6·0 "
4.	Red clay	3·5 "
5.	Argillaceous sand	6 to 18·0 "

and that, where they did not reach the roof, the deposits were covered with stalagmite.

On the authority of Mr. Clift and Prof. Owen, Capt. Mudge mentions relics of elephant, rhinoceros, horse, ox, sheep, hyæna, dog, wolf, fox, bear, hare and water-vole. The bones, and especially the teeth, of the hyæna exceeded in number those of all the other animals, though remains of horse and ox were very abundant. Mr. Bellamy, whilst also mentioning all the foregoing forms, with the exception of dog only, adds deer, pig, glutton, weasel and mouse. He also speaks of the abundance of bones and teeth of hyæna, but seems to regard the fox as being almost as fully represented; and next in order he places horse, deer, sheep, and rabbit or hare; whilst the relics of elephant, wolf, bear, pig and glutton are spoken of as very rare. The bones, he says, were found in the uppermost bed only. They were frequently mere fragments and splinters, some being undoubtedly gnawed, and all had become very adherent through loss of their animal matter. Those of cylindrical form were without their extremities; there was no approach to anatomical juxtaposition; and the remains belonged to individuals of all

ages. Reliquiæ of carnivorous animals greatly exceeded those of the herbivora, and teeth were very abundant. Coprolites occurred at some depth below the stalagmite, in the upper bed, which also contained granitic and trappean pebbles, and lumps of breccia made up of fragments of rock, bones, pebbles, and stalagmite. The bones found prior to 1835 had been removed as rubbish, and some good specimens were recovered from materials employed in making a pathway. Nothing indicating the presence of man appears to have been found.

The Ash-Hole.—On the southern shore of Torbay, midway between the town of Brixham and Berry Head, and about half a mile from each, there is a cavern known as the *Ash-Hole*. It was partially explored, probably about, or soon after, the time Mr. MacEnery was engaged in Kent's Hole, by the late Rev. H. F. Lyte, who, unfortunately, does not appear to have left any account of the results. The earliest mention of this cavern I have been able to find is a very brief one in Bellamy's "Natural History of South Devon," published in 1839 (p. 14). During the Plymouth Meeting in 1841, Mr. George Bartlett, a native of Brixham, who assisted Mr. Lyte, described to this Section the objects of interest the Ash-Hole had yielded (see Report Brit. Assoc. 1851, Trans. Sections, p. 61). So far as was then known the cave was thirty yards long and six yards broad. Below a recent accumulation, four feet deep, of loam and earth, with land and marine shells, bones of the domestic fowl and of man, pottery, and various implements, lay a true cave-earth, abounding in the remains of elephant. Prof. Owen, who identified, from this lower bed, relics of badger, polecat, stoat, water-vole, rabbit and reindeer, remarks, that for the first good evidence of the reindeer in this island he had been indebted to Mr. Bartlett, who stated that the remains were found in this cavern (see "Brit. Foss. Mam." 1846, pp. 109–110, 113–114, 116, 204, 212, 479–480). I have made numerous visits to the spot, which, when Mr. Lyte began his diggings, must have been a shaft-like fissure, accessible from the top only. A lateral opening, however, has been quarried into it: there is a narrow tunnel extending westward, in which the deposit is covered with a thick sheet of stalagmite, and where one is tempted to believe that a few weeks' labor might be well invested.

(To be continued.)

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On a modification of Dumas's Vapor-density method.*—Habermann has suggested a modification in the method proposed by Dumas for estimating vapor-densities, which consists in applying to this method the improvement in Gay Lussac's method suggested by Hofmann, of making the experiment under reduced pressure. For this purpose the neck of the balloon, which is made thick at the end, is connected, first with a double-bulb tube which serves as a receiver, and then through this with a Bunsen pump furnished with a manometer to indicate the residual tension. After the substance—about one gram—is introduced into the balloon, and this is lowered into the bath and connected to the pump, an exhaustion of 500 or 600 millimeters is effected, the cock to the pump is closed and the heating is proceeded with, a temperature higher than that at which the substance boils, never being required. After this point has been for a short time reached, the exhaustion is returned to its former point, the neck of the balloon is sealed by the blowpipe, and the thermometer, barometer and manometer read. The calculation is made as usual, only using instead of the barometric height at the time of sealing, the difference between this and that of the manometer, in the calculation for the reduction of volume.—*Liebig's Ann.*, clxxxvii, 341, June, 1877. G. F. B.

2. *On the action of Phosphoric chloride on Tungstic oxide.*—Teclu has proved that the sole products of the action of tungstic oxide upon phosphoric chloride are phosphoryl chloride and tungstic chloride (tungsten hexachloride). Equivalent weights—three molecules PCl_5 and one of WO_3—of the pure substances were sealed in glass tubes, well shaken, and heated in a paraffin bath to 200° C., for six or eight hours. On cooling, brilliant metallic steel-blue crystals appeared in the tubes, which swelled up in the air by attracting moisture and were rapidly decomposed. They were slightly soluble in absolute alcohol, more so in ether, and easily soluble in carbon disulphide. The contents of a tube was submitted to distillation, and the distillate proved to be phosphoryl chloride. The residue was heated to 120° and a current of dry carbon dioxide gas was passed over it. The last traces of $PO\,Cl_3$ were thus removed and the crystals obtained pure. For quantitative analysis, a weighed quantity was heated to 100° in a sealed tube with water and nitric acid, and the chlorine determined as usual. The result showed the crystals to be tungsten hexachloride. By slow cooling of the phosphoryl chloride solution, in the tubes where they are formed, the crystals may be obtained of considerable size. The crystals are isometric, and fuse at 189°. The reaction is given by the equation:—$WO_3+(PCl_5)_3=WCl_6+(POCl_3)_3$.—*Liebig's Ann.*, clxxxvii, 255, June, 1877. G. F. B.

3. *On the production of Tartronic from Pyruvic acid.*—GRIMAUX, in attempting to replace the two atoms of bromine in dibrom-pyruvic acid, by one of oxygen, by acting upon the acid by barium hydrate, has produced not $C_3H_2O_4$, the acid wished, but $C_3H_4O_5$, tartronic acid. The dibrom-pyruvic acid was dissolved in two or three times its weight of water, and barium hydrate gradually added, the temperature being kept at 30° to 40°. A white precipitate soon formed, which, decomposed by sulphuric acid, yielded a crystallized acid, very soluble in water and alcohol, fusing about 142°, and yielding the above formula on analysis. The author thinks that the mesoxalic aldehyde-acid CHO—CO—COOH is first formed, but that this body being at the same time an aldehyde and an acetone, is oxidized on its aldehydic side and reduced on its acetonic. Hence it is hydrated and gives COOH—CHOH—COOH, which is tartronic acid. The reaction is

$$\begin{matrix} CHBr_2 \\ | \\ CO \\ | \\ COOH \end{matrix} + (H_2O)_2 = \begin{matrix} COOH \\ | \\ CHOH \\ | \\ COOH \end{matrix} + (HBr)_2,$$

analogous to the transformation of dichloracetone into lactic acid. —*Bull. Soc. Ch.*, II, xxvii, 440, May, 1877. G. F. B.

4. *On a Hexyl Chloral.*—PINNER has subjected to a more careful examination an oily body of high boiling point, first observed by him nearly two years ago in the distillation of crude butyl chloral. From a kilogram of this oil from the factory of Schering, he has prepared half a pound of the oil boiling between 212° and 220°, the rest being butyl chloral. Further fractioning gave him a portion boiling at 212°—214°, which gave on analysis the formula $C_6H_9Cl_3O$. It does not unite with water to form a hydrate and is decomposed by strong bases into a formate and chloride of the base and into $C_5H_8Cl_2$. It is oxidized by nitric acid and yields trichlorcapronic acid, $C_6H_9Cl_3O_2$. Reducing agents, such as zinc powder, reduce this acid to hexylenic acid $C_6H_{10}O_2$, which crystallizes from ether in brilliant white needles, fuses at 39°, is almost insoluble in water, and does not appear to be identical with any of the three known acids having the same empirical formula.—*Ber. Berl. Chem. Ges.*, x, 1052, June, 1877.

G. F. B.

5. *On the Conversion of Aurin into Rosaniline.*—DALE and SCHORLEMMER have discovered that red aurin or peonin, heated for several days to 150° with alcoholic, or to 200° with aqueous ammonia, loses its red color and gives a yellow solution, which contains a colorless crystalline base possessing all the properties of rosaniline, giving the well-known magnificent red color with acetic acid and a dark yellow solution with hydrochloric acid, which becomes red on dilution and gives a spectrum identical with that of rosaniline hydrochlorate. Conversion into Hofmann's violet, aniline green and aniline blue still farther confirmed this identity. The reaction is given as follows:—$C_{20}H_{14}O_3 + (NH_3)_3 = C_{20}H_{17}N_3 + (H_2O)_3$. The authors regard aurin and

rosolic acid as identical.—*Ber. Berl. Chem. Ges.*, x, 1052, June, 1877. G. F. B.

6. *On Hematin.*—Cazeneuve has prepared hematin and examined its properties. For its preparation, defibrinated blood was treated with twice its volume of commercial ether, allowed to stand twenty-four hours, the ether decanted from the clot, and this clot exhausted by the ether containing now two per cent of oxalic acid. The etherial solution, colored a brownish-red by the hematin, was exactly saturated by ether charged with ammonia gas, and the precipitated hematin was collected, washed with water, alcohol and ether and then dried. The product is pure hematin. In presence of alcohol and ether, it combines readily with hydrochloric, hydrobromic, and hydriodic acids, giving crystallized compounds. On analysis, it afforded 64·18 per cent of carbon, 5·67 hydrogen, 9·03 nitrogen, 8·74 iron and 12·38 of oxygen, corresponding to the formula $C_{68}H_{70}N_8Fe_2O_{10}$. Though it combines with alkalies, it yields no crystalline products. Its ammonia compound is stable at 100°. With lead, zinc, and aluminum hydrates, it gives greenish lakes. It does not disengage ammonia, when boiled with a concentrated solution of potash in alcohol for hours. Heated to 150° for two hours in a sealed tube with concentrated hydrochloric acid, the solution becomes remarkably dichroic; and the hematin splits into two substances (A) and (B). The first is obtained pure by the dialysis of the solution till it is no longer acid. It exists as suspended flocks, the liquid being precipitated completely by a single drop of ammonia, yielding a gelatinous mass containing 37·62 per cent of iron. Its spectrum is peculiar; in acid solutions, it consists of two strong absorption bands in the yellow and yellow-green, in alkaline solutions, it gives four bands, one in the red, one in the yellow-green, one in the blue and one in the violet. The other substance (B) is the part insoluble in hydrochloric acid. On washing it, dissolving it in soda and precipitating by acetic acid, it is purified. It contains only 2·08 per cent of iron, and its solution in acid alcohol gives a one-banded spectrum, in alkalies, a four-banded one.—*Bull. Soc. Ch.*, II, xxvii, 485, June, 1877. G. F. B.

7. *On the Nature of what is commonly termed a "Vacuum;"* by G. Johnstone Stoney, Queen's University, Dublin, August 19, 1877.—The readers of Mr. Preston's paper in the August number of the Philosophical Magazine, "On the Nature of what is commonly termed a 'Vacuum,'" might perhaps suppose with him that the subject is one which had not been previously noticed, and conclude that we are as yet without an explanation of "Crookes's force," in which the vast multitude of the gaseous molecules that are present has been taken into account.

The subject is one which cannot, I should think, have been overlooked by any real student of the molecular theory of gases; and in particular your readers will find it thus treated in a paper that I presented ten years ago to the Royal Society (see Phil. Mag. [IV], vol. xxxvi, p. 141):—"It is therefore probable that there are

not fewer than something like a unit-eighteen of molecules" [i. e. 1,000000,000000,000000] "in each cubic millimeter of a gas at ordinary temperatures and pressures. Hence we may see how entirely remote from a state of emptiness that which usually passes under the name of a vacuum-chamber really is. If there be a unit-eighteen of molecules in every cubic millimeter of the air about us, there will remain a unit-fifteen" [i. e. a thousand millions of millions] "in every cubic millimeter of the best vacuums of our ordinary air-pumps. The molecules are still closely packed, within about an eighth-meter of one another; i. e. there are about sixty of them in a wave-length of orange light." And in two papers published in last year's Philosophical Magazine [V], vol. i, pp. 177 and 305, I offered an explanation of the mechanical stresses within Crookes's radiometers based upon this very consideration: see in particular page 178, where the following words occur:—"I cannot refrain from observing here how entirely remote such a chamber" [viz. a Sprengel vacuum indicated by one-tenth of a millimeter of mercury] "is from being empty. It follows from what we know of the number of molecules in gases at ordinary pressures, that the number remaining in this so-called vacuum will be somewhere about a unit-fourteen, i. e. one hundred millions of millions, in every cubic millimeter." After which I quote, in proof of this assertion, the determinations of the mean interval at which the molecules of gases are spaced, by Professor Loschmidt in 1865, by myself in 1867, and by Sir William Thomson in 1870.

It is plain, however, that Mr. Preston has done good service by recalling attention to the immense number of the molecules, and the consequent shortness of the excursions of each molecule between its successive encounters with other molecules; since the subject was new to himself, and had been overlooked by some of the writers upon Crookes's radiometer.—*Phil. Mag.*, Sept. 1877, p. 222.

8. *Note on the Telephone;* by PAGET HIGGS.—In the present agitation concerning speaking or telephonic telegraphs, the following extract from M. Le Comte du Moncel's "Exposé des Applications de l'Electricité," edition of the year 1857, vol. iii, p. 110, may be interesting as pointing out how nearly the idea has been forestalled.

"*The Electric Transmission of Speech.*—I did not wish to bring forward in the chapter of the electric telegraph a fantastic conception of a certain M. Ch. B——, who believes that it will be possible to transmit speech electrically, because it might have been asked why I had classed among so many remarkable inventions an idea that, presented by the author as it is, is not more than a dream. However, to be faithful to the *rôle* that I have imposed upon myself of speaking of all the applications of electricity that have become known to me, I wish to quote here the information which the author has published on this subject.

'After the marvelous telegraphs which are able to reproduce at a distance writing of this or that individual, and designs more or

less complicated, it seemed impossible, said M. B——, to advance further in the region of the marvellous. Nevertheless, essaying to do something more, I asked, for example, if speech itself would not be capable of transmission by electricity; in a word, if one would not be able to speak at Vienna and be heard at Paris. The thing is practicable. This is how: Sounds, it is known, are formed by vibrations and carried to the ear by these same vibrations, which are reproduced by the intermediate media.

'But the intensity of these vibrations diminishes very rapidly with the distance, from which it follows, even in the employment of speaking trumpets, tubes, and of acoustical horns, the limits which cannot be surpassed are very restricted. *Imagine that one speaks near a mobile plate, flexible enough not to lose any of the vibrations produced by the voice, that this plate establishes and interrupts successively the communication with a battery. You would be able to have at a distance another plate which would execute at the same time the same vibration.*

'*It is true that the intensity of the sounds produced would be variable at the point of departure where the plate is vibrated by the voice, and constant at the point of arrival where it is vibrated by electricity.* But it is demonstrable that this would not alter the sounds.

'It is evident from the first that the sounds would reproduce themselves with the same pitch in the scale. The actual condition of acoustical science does not permit of saying, *à priori*, whether the same conditions would hold good for all syllables articulated by the human voice. The manner in which these syllables are produced is not yet sufficiently well known.

. . . . . .

'In any case it is impossible to demonstrate, in the present state of science, that the electric transmission of sounds is impossible. Every probability, on the contrary, is for the possibility. An electric battery, two vibrating plates, and a metallic wire will suffice.

. . . . . .

'It is certain that, at a time more or less distant, speech will be transmitted to a distance by electricity. I have commenced some experiments to that effect, they are delicate and require time and patience. But the approximations obtained point toward a favorable result.' "—*Nature*, of Aug. 30.

II. Geology and Mineralogy.

1. *Archæan of Canada.* (Letter from Mr. Henry G. Vennor, of the Geological Survey of Canada, to J. D. Dana, dated Buckingham, July 10th, 1877.)—I take the liberty of addressing this letter to you, on a subject in which I have for some years been particularly interested, viz: the stratigraphical position of the economic minerals in what we have hitherto called the Lower Laurentian system of rocks.

I may briefly give you the results arrived at, after now some ten years' work in Eastern Ontario and the adjoining portion of the Province of Quebec, namely, Pontiac and Ottawa counties. We find that there still exists a great *Azoic* formation, consisting of syenite and gneiss (?) without crystalline limestones. In this there are but little indications of stratification. Occasionally a limited surface presents an approach to an *obscure stratification*, but this does not appear to be due to the deposition of sediment. This rock forms the back-bone of Canada. On it there has been deposited a great series of gneisses, schists, slates, crystalline limestones and dolomites, which, although heretofore grouped with the former, is clearly distinct and unconformable. This second system contains *all of the economics* of any importance; none having been found in the old fundamental red gneiss system. All of these economics are in close proximity and have close relationship to each of the four or five great bands of crystalline limestone.

Eozoon Canadense belongs undoubtedly in the main to the highest band of crystalline limestone yet found, although this fossil may, and indeed has been sparingly found in some of the lower limestones. The celebrated Petite Nation locality for *Eozoon*, has now been proved to be on this highest band of limestone, and in fact in *the most recent portion of my second system;* the zone of limestone in which this fossil occurs is especially characterized by an abundance of serpentine and chrysotile. It is further traversed by veins filled with baryta and galena, and these also extend up through the Potsdam and Calciferous formations, but do not enter far into the crystalline rocks, both minerals rapidly giving out as we descend into these older rocks; while the fissures themselves narrow to threads and bifurcate. This fact has been proved by a close and careful investigation in Rossie, N. Y., and Lansdowne, Loughbon, Bedford, Madoc, and Tudor, in Canada.

Immediately beneath the *Eozoon* limestone the apatite-bearing belt of rocks come in with horizons of both hematitic and magnetic iron ores—chiefly the former; and immediately below these again a great belt of plumbago-bearing rock (extensively wrought for this mineral in Buckingham and Lochaber, Ottawa county), an important volume of crystalline limestone filled with rust-colored lumps and beds. This band of limestone is the second in descending order. A short distance beneath this last (some twenty or thirty chains), is an important and well-marked horizon of magnetic iron ore—occasionally with layers of hematite, in which occur a number of promising mines (e. g. the Baldwyn and Forsythe mines, Hull, P. Q.; the Christies' Lake and Silver Lake mines in South Sherbrooke, Lanark county, Ontario, etc.)

On a still lower horizon and close to the third belt of limestone, there is another iron ore horizon of coarsely crystalline magnetite with apatite intimately associated, which has now been identified and followed continuously for upwards of one hundred miles.

Lastly, in a still lower, fourth and last important volume of limestone, we find some large deposits of hematite iron ore (e. g. the Cowan mine in Dalhousie township, Lanark county), but these in so far as investigated, are superficial deposits, only penetrating some fifty or eighty feet into the limestone; but the particular layer in which they occur may be followed by its deep hematite red color throughout a great extent of country.

The order then thus given to the economic minerals, just mentioned, is, in ascending order, as follows:—1st, hematitic iron ore; 2d, magnetite and apatite (unimportant); 3d, magnetite and hematite (important); 4th, plumbago (very extensive); 5th, phosphate of lime, with iron ores (an important and extensively worked belt; and then 6th, *Eozoon Canadense* in abundance with serpentine, chrysotile and veins of baryta and galena.

You will thus observe that iron ore runs through the series, though most important in one horizon; that plumbago (with a great deal of pyrites cobaltiferous) is toward the upper portion; while the great body of apatite-bearing rock is at the very summit.

Having established this important sequence my thoughts at once flew back to the discoveries of phosphatic nodules and shells in the Lower Silurian rocks at the Allumettes Rapids (Geology of Canada, page 125), and in several places in the eastern townships and elsewhere. Is it not probable that the source of our mineral apatite is in the Lower Silurian rocks, whence it has penetrated into the upper portion of the *second division* of the Laurentian system? Or, may the *Eozoon* not have furnished a considerable portion of the supply? Possibly *Lingulæ* may have abounded along with the Eozoon, but if so their remains have been entirely obliterated by crystallization or other metamorphism. I think that the gap between the Lower Silurian and uppermost crystalline rocks of the Laurentian is considerably lessened by the results of our explorations, particularly as we can show that the same veins which cut the former, affect the latter, but do not reach the fundamental *Azoic* system, to which I must now (in my section) restrict the term Lower Laurentian. I cannot now enlarge, but I may simply state that I consider both the Huronian and Upper Laurentian of Sir W. E. Logan to belong rightly to my second division, which I must for the present call Upper Laurentian. Should an Upper Laurentian yet be found above and unconformable to *my series*, then I have been working on a middle series, to which the term Huronian might as well be applied as any other.

I have found Labradorite rocks clearly interstratified with several of my bands of limestone, and I fail entirely to discover Sir William's upper distinct system—yet I have been over the same ground.

The *Huronian and Hastings series of rocks* I believe to be simply an altered condition, on their westward extension, of the lower portion of my *second system;* and this alteration commences as this portion reaches Hastings county, where you will

remember Hunt, Macfarlane and others likened them to the Huronian, while Sir William thought they more resembled some portions of the Devonian.

2. *The Geology of New Hampshire.* C. H. HITCHCOCK, State Geologist, J. H. HUNTINGTON, WARREN UPHAM, and G. W. HAWES, Assistants. Part II, Stratigraphical Geology. 684 pp. Royal 8vo, with many maps, plates, and sections. Concord, 1877. —This large volume consists mainly of chapters by Professor Hitchcock. The geology of the Coös and Essex Topographical district and of the west part of the Merrimac district, and some other brief sections are by Mr. J. H. Huntington.

The difficulties of the survey have been great on account of the extent of the surface covered by unbroken forests, and the disturbed crystalline condition of the rocks. But, through great labor, the distribution of the several kinds of metamorphic rocks has been to a large extent made out, and is carefully described in the Report. Professor Hitchcock has carried forward the work with energy and fidelity, and has presented not only his own views, but also, with fairness, as far as he has understood them, the views of others. As to the conclusions from the facts presented in the volume, Professor Hitchcock is aware that the writer differs from him in many points; and if in the remarks beyond some of these differences are mentioned it will be without the assumption on the writer's part that he is always right.

Professor Hitchcock refers the crystalline rocks of New Hampshire—taking his latest conclusions from the closing pages of the volume—to the following groups in ascending order:—Laurentian; Montalban (inferior to Huronian, and so named from the Latin for White Mountains); Lower and Upper Huronian; above these, Paleozoic with a query; Cambrian; the Coös group; the Calciferous mica schist; and above these, the Lower Helderberg. Besides, there are various areas of eruptive granite recognized, including those of the "Conway granite," "Albany granite," "Chocorua series," and others.

The *Laurentian* includes a porphyritic gneiss, Bethlehem gneiss, Lake Winnipiseogee gneiss; the *Montalban*, Concord granite, feldspathic mica schists, the associated gneisses, fibrolite schists; the *Upper Huronian*, hornblende schist, chlorite schist, greenstones, and other rocks; the *Coös*, staurolite slate, staurolitic mica schist, quartzyte; overlying the Coös, Calciferous mica schist, in which obscure crinoidal fragments have been found.

The age of these rocks, the Helderberg excluded, has been determined by Prof. Hitchcock mainly by lithological characteristics—a species of evidence not yet proved to be satisfactory. The writer is led by his observations among New England rocks to conclude that, so far as lithological distinctions go, all the metamorphic rocks of the White Mountains, with perhaps one or two exceptions, might belong to one of the ages in geology: (and that even one stratum may, after metamorphism, be, in its different parts, andalusite slate, mica schist, andalusitic mica schist, gneiss,

porphyritic gneiss, granite). As to what age, or whether to one, or to more than one, the facts thus far collected afford no satisfactory basis, as the writer believes, for a decisive opinion. Further: observations in different parts of New England have convinced him that the granites, supposed by Professor Hitchcock to be eruptive, may be for the most part, if not in all cases, metamorphic; and this appears to be sustained by the facts, as to position and relation to the other rocks, connected with the granite of Mt. Willard (one of the areas made eruptive), as is pointed out beyond.

The account of the White Mountain region occupies 170 pages of the Report, and will attract especial attention. Following this comes a chapter on the geology of the Connecticut Valley, which also is of prominent importance in connection with New England geological investigations.

The chief facts of interest in the valley region is the occurrence at three places of limestone containing Lower Helderberg fossils—corals, crinoids, or brachiopods, associated with various metamorphic rocks. These places are in Littleton and North Lisbon, New Hampshire, and in Bernardston, Massachusetts. The limits of the Helderberg areas are laid down with some acknowledged doubts as to whether the group does not embrace also the "Coös group;" and there is room left for a query whether they should not include also what is called the "Lisbon group" (chlorite schist, chlorite rocks or greenstones, with some hydromica slate, etc.), and the "Lyman group." The section given on page 326 of the Littleton rocks represents a synclinal of slate (the uppermost bed), limestone, and quartzyte, with beds of the "Lisbon group" and "Lyman group" essentially *conformable* to the limestone. Plate xv (facing p. 385), contains another section of this region, showing the same conformability of the Lyman, Lisbon, and Helderberg groups. On pages 329 and 331, this conformability is again exhibited in sections, and also on plate XIII. Professor Hitchcock, however, calls the Lisbon and Lyman groups Huronian, a conclusion that is not suggested by the above-mentioned sections.

The relations of the Helderberg limestone of Bernardston to the associated micaceous, hornblendic and other rocks the writer has interpreted very differently from Professor Hitchcock, and he will give the results of new observations in another number of this Journal.

Some of the most interesting facts in the White Mountain region are those observed along the valley west of the Mount Washington range of peaks. This valley, at the Notch and south of it (here trending about north-and-south), has Mount Willard and Mount Willey on the west (the latter two miles south of the former), and Mount Webster on the east, opposite Mount Willey. The rocks of the west side in this part are, going southward, a light-colored well characterized granite ("Conway Granite"), the chief constituent of Mount Willard, in view above the Notch;

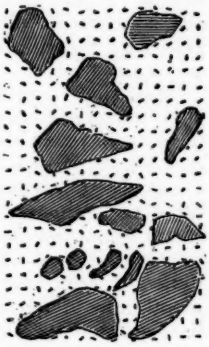
a hard siliceous granitoid gneiss, varying into true granite, forming the eastern foot of Mount Willard, to the east of the Mount Willard granite, in the Notch; then, continuing southward, but at first a little westward, andalusite slate, meeting the Mount Willard granite parallel with its bedding, as if conformable to it, and extending southward to the top of Mount Willey; then, on the southeast side and foot of Mount Willey, the Mount Willard granite again, which becomes, five miles south of the Notch, at the Frankenstein cliff, a dark gray granite for some distance, and then changes abruptly to syenyte.* The andalusite slate where it adjoins the Mount Willard granite is, for a varying width—twenty feet below and two hundred feet above—an argyllyte-porphyry, it containing orthoclase and quartz, both of which minerals are in distinct crystals within a few yards of the granite.

The rocks of the *east* side of the valley are, just north of the Notch, well characterized gneiss; then, at the Notch and below it, the same hard granitoid gneiss that occurs on the west side, seldom distinct in dip and strike; then farther south, Conway or Mount Willard granite, at the base and up the slope of Mount Webster; and above this, far up the sides of this mountain, the "Montalban schists" (feldspathic mica schist chiefly), the characterizing rock of the Mount Washington range. The rocks of the region and of Mount Washington dip, with some local exceptions, to the westward.

The above facts respecting the rocks are here cited from the Report, as an introduction to a point of very prominent interest—the existence in the valley of a long series of great veins of coarse granite, and of a remarkable range of "breccia-granite." These veins are numerous and large at the Notch; and they occur also to the south, on nearly the same line, far up the western slope of Mount Webster, where some of them are twenty to thirty feet wide. The breccia-granite has the same general range with the veins. Just below the Notch, on its western side, there is a large exposure of it, and it here extends, Professor Hitchcock observes, "1,200 feet along the railway." Going southward in the gorge or valley, this breccia-granite appears at the outlet of Dismal Pool, and then, south of this, in a cliff on the west side of Mount Webster, at a height equal to that of the top of Mount Willard, where it has a thickness of two hundred to three hundred feet. Its course, southerly from the Notch, "is not in a right line, on account of various shiftings of the rock, not fully understood." This breccia-granite is made up of large and small masses of chiefly a dark micaceous gneiss, in a paste of granite, some of the masses a yard in length.

* According to the writer's observations at the place, the granite becomes syenyte by a substitution of hornblende for black mica (biotite). The other ingredients are precisely the same—gray feldspar and gray quartz, so that the two rocks are stratigraphically one. It is an interesting example of the abrupt transition between these two rocks, and is well worthy of a visit from those who are interested in lithological questions. The idea that the two rocks were perhaps upper and lower parts of one original stratum or successive strata was considered, but without finding reason to sustain it.

Again: a similar breccia-granite occurs one to two miles north of the Notch, (pp. 163, 165). Two miles southwest of Crawford's, on Cascade Brook, the Mount Willard granite "contains many fragments of the hard Montalban schists, sometimes from twelve to fourteen feet long; and several of them seem to carry andalusite quite abundantly."* Half a mile farther west up this same brook, andalusite slate succeeds to the granite (but with an intermediate porphyritic junction-rock, like that observed in Mount Willard), and it continues up Mount Tom.



The writer had the pleasure, in 1875, of examining this part of the White Mountain region with Professor Hitchcock, and adds here a cut representing a portion, six feet wide, of the surface of breccia-granite, just below the Notch.

The great number and large size of the granite veins extending along the gorge in a north-and-south direction, and the extensive range of breccia-granite following the same course, seem to sustain the opinion, which Professor Hitchcock quotes in his Report from the writer, that the gorge, like most valleys of the Appalachians, was probably the course of a lofty anticlinal, the fractures in which led to degradation and so determined the formation of the valley. And if this conclusion be right, the Mount Washington range may correspond to a nearly parallel synclinal. From the position of the rocks in the gorge above described, it seems probable that the hard siliceous granitoid gneiss of the Notch is the central and lowest rock of the anticlinal; that the Mount Willard (or Conway) granite is the next metamorphic stratum on *both* the east and west sides, it lying conformably against the slate in Mount Willard and elsewhere; and that the andalusite slate on the west and the Montalban schists (often andalusitic, and part an andalusitic slate) together on the east, constitute the succeeding stratum. The dissimilarity in the eastern and western portions of this last stratum may be a consequence of a small variation from east to west in the constitution of the sediments and of differences in the degree of metamorphism. The dissimilarity is chemically small; for the analysis of the andalusitic slate from this region by Mr. G. W. Hawes (Report, p. 233) found it to consist (No. 1, below) of—

	SiO_2	AlO_3	FeO_3	FeO	MnO	MgO	K_2O	Na_2O	TiO_2	H_2O
1.	46·01	30·56	1·44	6·85	0·10	1·42	6·66	1·12	1·91	4·13=100·22
2.	46·23	33·08	3·48	---	---	2·10	8·87	1·45	---	4·12= 99·28

which corresponds very nearly to the constitution of common mica (muscovite), or rather the hydrous variety margarodite, one

* A similar breccia-granite occurs in the Franconia Notch, near the Basin, where (p. 137 of Professor Hitchcock's Report) masses "of porphyritic granite, dark gneiss, hornblendic and other siliceous rocks, are cemented together by a light-colored feldspathic paste." Other localities also are mentioned.

analysis of which is cited in No. 2; and also, for half of it, as Mr. Hawes suggests, to that of common feldspar (orthoclase). The slate is peculiar in affording so large a percentage of alkali (7·78), and so small of silica; but it varies in its silica, being in some places an "argillaceous quartzyte;" in others a "felsitic slate," weathering white.

This view that the andalusite-slates and Montalban schists (which also are often andalusitic) correspond to a stratum *higher* in the series than the Mount Willard granite is sustained by the occurrence of masses of them in the bed of granite on Cascade Brook (see above); for in the fracturing and crushing of the rocks, the detached masses would naturally fall to the level of the lower strata from those above. The breccia-granite the writer attributes to a crushing of the walls of great fractures during the period of upturning and metamorphism,—the metamorphism of the fragments and of the rock fractured, and the making of the granite, having gone on in the same epoch, like the making of the granitic veins; and not, as held by Professor Hitchcock, to the breaking up of schists long before made by metamorphism, and the including of the fragments in eruptive granite. The crushing was on a vast scale; and it may have been far beyond what is now indicated; for we cannot know to what extent the stratum which is now Mount Willard granite was crushed, all trace of bedding being obliterated. What is apparent shows where the heat required for metamorphism, and for the making of granite, came from.

The strike of the andalusite slate from its southern point at the summit of Mount Willey, northward, is, according to Professor Hitchcock, N. 10° E., and it varies little from this except adjoining the Mount Willard granite, where for one or two hundred rods it has a bend to the westward. The northern limit of the narrow slate area is in the high region northwest of Mount Willard, the whole length being about ten miles. A finely porphyritic or "spotted" granite named the "Albany granite," is stated to bound it on the west and to occur where it disappears to the north. Whether the slate disappears by dipping beneath the granite, or by passage into it, is not stated. This Albany granite is in the larger part a granite without quartz (p. 143), and hence may have nearly the constitution of the slate.

Professor Hitchcock states that the porphyritic granitoid rock, ten to two hundred feet wide, which marks the junction in Mount Willard of the andalusite slate and Mount Willard granite, resembles the "Albany granite." This peculiar junction-rock indicates, in the writer's view, that the stratum of granitic mud or sand from which the Mount Willard granite was made, and that from which the andalusitic slate proceeded, had some beds of passage; there was a transition in the metamorphic products because of a transition in the material and in other conditions.

The structure of the White Mountains is so exceedingly complex, that it may reasonably give rise to widely diverse explanations. The view the writer has here presented seems at least to be worth considering in the future study of the region.

The volume also treats of the rocks of the Merrimack district, the Lake district, the Coast district, and the district of northern New Hampshire.

The Geological Map, illustrating this volume, is in the hands of the engraver. It is on a scale of two and a half inches to the mile.

The third and last volume of the Survey will contain a report by Mr. Warren Upham on the Quaternary of New Hampshire; and one by Mr. George W. Hawes, on the Lithology of the State, both chemically and microscopically considered. J. D. D.

3. *Preliminary Report on the Paleontology of the Black Hills*, by R. P. WHITFIELD. U. S. Geogr. and Geol. Survey of the Rocky Mountain region, J. W. POWELL in Charge. 50 pages, 8vo, July, 1877. Washington.—This valuable report contains descriptions of new species of fossils from Primordial, Jurassic and Cretaceous formations; and in the final report on the paleontology of the Black Hills, it will be accompanied with sixteen lithographic plates. The new Primordial fossils include besides a fucoid, two species of *Lingulepis*, and two of trilobites of the genus *Crepicephalus* (*Loganellus*), *C. centralis*, and *C. planus;* the new Jurassic, species of *Pecten*, *Pseudomonotis*, *Mytilus*, *Trapezium*, *Pleuromya*, *Tancredia*, *Dosinia*, *Psammobia*, *Necæra*, *Saxicava;* and besides there are eighteen new species of Cretaceous fossils. In all, the number of Jurassic species recognized from the Black Hills by Mr. Whitfield, is thirty-three, and of Cretaceous species, seventy. The sixteen lithographic plates are full of well-drawn and finely engraved figures.

4. *The Age of the Tejon group, California.*—The following is from a paper by Dr. J. G. COOPER in the Proceedings of the California Academy of Sciences, for Nov. 16, 1874.—The evidence of the age of the Tejon group is so far derived from only a few marine fossils which have been referred by different authors to the Cretaceous, the Eocene, and the Miocene. Conrad, the Nestor of American paleontologists, over twenty years ago, described as unmistakably Eocene, a group of fossils, now known as the Tejon group, among which he thought was the *Cardita planicosta*, "that finger-post of the Eocene, both in Europe and America." Mr. Gabb, finding from better specimens that this shell differed from *Cardita planicosta*, described it as new, and referred the Tejon group to the Cretaceous, finding in it a very few species which he considered identical with the lower beds, proved to be Cretaceous by the presence of numerous Ammonites. He also stated, in an article in our Proceedings, published November, 1866, that "a solitary ammonite, represented by half a dozen specimens, has been found by myself *in place*, even to the very top of the formation." This slender evidence (which might be rejected after finding a Carboniferous fossil in a Pliocene deposit) is all the proof we have of the Tejon beds being Cretaceous; and that it is quite arbitrary is shown by the other fossils found with it being nearly all different from the lower ones, less than one-tenth of the Cretaceous shells being

common to both according to Gabb, of which several *may be* distinct. On the other hand, many of the Tejon group are scarcely distinguishable from Tertiary and living forms. One, *Aturia Mathewsonii*, is so near the Eocene *A. zigzag*, as to have been taken for it, no other Cretaceous *Aturia* being known.

I may add that the ammonite (*A. jugalis* Gabb) was found by me in a stratum just beneath the Mt. Diablo coal, and apparently on the same level as those from Clayton and "Curry's," found by Gabb, so that its existence above the Coal, or in the Tejon group itself, is perhaps accidental. But, to pass by this doubtful fact, we have still later strata, referred to the Eocene by Conrad, near the mouth of the Columbia, where we would expect the first Tertiary to rise near the surface, and this time the Eocene *Aturia zigzag* again appears, though with a different group of shells. Mr. Gabb, while admitting that this time it is the true *zigzag*, is so opposed to recognizing any Eocene here, that he calls the formation Miocene. The general character of these fossils, of which there are several in the Academy's Museum, shows, however, that they are of a more tropical growth than any of our Miocene species, the *Aturia* itself being very similar to the *Nautili* now living in the tropics. Though perhaps mixed with Miocene species among the broken rocks so numerous on the lower Columbia shores, it is most probable that true Eocene strata exist there, and, as shown by the Academy's specimens, extend south nearly to California, where later strata cover them. From all we yet know, we may assume that the gap between the Cretaceous and Tertiary, so marked on the Atlantic shores, was bridged over in part by the existence here of the "Tejon Group," continuing Cretaceous forms of mollusca down so as to be contemporaneous with the Eocene epoch there, or the earlier part of it, just as we find the flora and fauna of Australia resembling forms fossil in the Eocene formation of Europe, but continued to the present epoch. After, perhaps, a short geological period of convulsion and death, we find the Eocene mollusca appearing in Oregon, just preceding the Miocene, nearly like those of the Atlantic basin.

5. *Fossil Tertiary Insects of Quesnel, British Columbia.*—Mr. S. H. Scudder has described, in the Canada Geological Report for 1875–76, the following Columbian Tertiary species of insects. Hymnopters: *Formica arcaria*, *Pimpla saxea*, *P. senecta*, *Calyptites* (n. gen.) *antediluvianum*. Dipters: *Boletina sepulta*, *Brachypeza abita*, *B. procera*, *Trichonta Dawsoni*, *Anthomyia inanimata*, *A. Burgessi*, *Heteromyza senilis*, *Sciomyza revelata*, *Lithortalis* (n. gen.) *picta*, *Lonchæa senescens*, *Palloptera morticina*. Coleoptera: *Prometopia depilis*. Hemiptera: the Aphid, *Lachnus petrosum*, with mention of an imperfect specimen of a Neuropter.

6. *On the first discovered traces of Fossil Insects in American Tertiaries, and on new Carabidæ from the interglacial deposits of Scarborough Heights, near Toronto, Canada*, by Samuel H. Scudder. From the Bulletin of the U. S. Geol. and Geogr. Survey, F.

V. Hayden, U. S. Geol.-in-Charge.—The Tertiary Insects described by Mr. Scudder include species of Hymenoptera of the families *Formicidæ*, and *Ichneumonidæ;* Diptera of the families *Culicidæ*, *Chironomidæ*, *Cecidomyidæ*, *Tipulidæ*, *Mycetophilidæ*, *Cyrtidæ*, *Synphidæ*, *Muscidæ* and *Helomyzidæ;* various Coleoptera and Hemiptera; and a Neuropter of the genus *Phryganea.*

7. *Geological Survey of Victoria*, No. IV. *Report of Progress* by the SECRETARY OF MINES, *with Reports on the Geology, Mineralogy and Physical Structure of various parts of the Colony*, by R. A. F. MURRAY, F. M. KRAUSÉ, N. TAYLOR, A. W. HOWITT, W. NICHOLAS, J. COSMO NEWBERY, and Professor F. McCOY.—The Report of Progress states the following facts brought out in Decade IV of the Prodromus of the Paleontology of Victoria by Professor McCoy, which is nearly ready for issue. Three plates are devoted to the *Diprotodon* which, "like the Megatherium of South America, was obviously a feeder on the twigs and foliage of trees, like their diminutive representatives of modern times." On Plate V are represented *Favosites Goldfussi*, "agreeing in every respect with the European Devonian coral," *Spirifera lævicosta*, a species also of England and abounding in the Middle Devonian limestones of the Eifel, *Chonetes Australis*, "closely allied to the *C. sarcinulata* of the Rhenish Devonian beds," *Asterolepis ornata*, "almost identical with specimens found in the Russian Old Red Sandstone;" on Plate VI are figures of *Archæopteris Howitti*, *Sphenopteris Iguanensis*, and *Cordaites Australis*, from the Upper Devonian of Gippsland.

Mr. Howitt describes the basalts, and other rocks of North Gippsland, and gives figures of thin slices of the rocks, with detailed descriptions. The volume contains also facts on other formations in Victoria, and much on auriferous veins.

8. *Tantalite.*—I have lately had sent to me a mass of tantalite, weighing about 500 grams, coming from Professor Eugene A. Smith, State Geologist of Alabama; its exact locality in Alabama is not given. It is the first time that tantalite has been found in the United States; its specific gravity is over 7·2. It is a surface specimen, and has undergone partial decomposition in the crevices. It is an important discovery at the present time, while this class of minerals is exciting interest. J. LAWRENCE SMITH.

9. *Geognostische und geographische Beobachtungen im Staate Minnesota.* Doctorate Inaugural dissertation by J. H. KLOOS, Mining Engineer of Amsterdam. 58 pp. 8vo. Berlin, 1877.

III. BOTANY AND ZOOLOGY.

1. *Morphology of the Dentary System in the Human Race.*—Dr. E. LAMBERT, of Brussels, has given the characteristics of the teeth in the different races of Man a careful study, and has arrived at the following important conclusions, here derived from the Bulletin of the Royal Academy of Belgium, 46th year, No. 5, 1877.

In the *white race*, the triturating surface of the canines does not project beyond that of the other teeth, the two premolars are equal in volume, the first true molar is the largest, and the last or wisdom tooth is the smallest. In the *black race*, the contrary is true in all these points, the canines projecting beyond the teeth adjoining, the posterior premolar being the largest, and the true molars increasing in size posteriorly.

In the white race, the molars have ordinarily only four cusps; in the black, five. If in the white race there are five, it is the first molar which has them; while in the black it is the last.

In the yellow race, there is usually a slight increase in the size of the molars from the interior to the posterior, as in the black race; and, as in the black race, there is a fifth cusp on the wisdom tooth.

In the black race, the diameters of the incisors are larger than in the white race, and the triturating surface of the canines is larger than that of the teeth adjoining.

In the black race, there is a slight diastema, which does not exist in the white race, and the inner tubercle of the premolar is less developed than the outer—as in the man-apes. In the inferior premolars, the first has often an inner tubercle feebly developed, which again manifests a slight approximation toward the man-apes.

In the black race, the superior molars have the antero-posterior diameter equal to the bi-lateral; in the white race, it is always smaller, and, in the yellow, the form is intermediate.

There is more difference in the teeth between the black race and the yellow than between the yellow and the white. However, the Malay branch, the type of the brown race of D'Omalius, seems to be transitional between the black and the yellow as regards the general volume of the teeth, the number of cusps of the large inferior molars, and the tendency to an increase of size of molars posteriorly.

The American race—the red race of D' Omalius usually united with the yellow—presents so nearly the dentary characters of the black race that Dr. Lambert unites the two. The Australians, Tasmanians, and New Caledonians present, in some respects, an exaggeration of the dentary characters of the African negro, and also stronger prognathism.

The crania from the caves of Furfooz (Belgium), have the inferior molars decreasing in size backward, as in the white race; and it is the same with the seventy neolithic crania exhumed at Hastières. But the Paleolithic lower jaw from Naulette (Belgium), as has been remarked by MM. Prüner Bey, Broca and Carter Blake, approximates most that of the Australian and New Caledonian races, showing a resemblance in the age of the mammoth between man in Belgium and the existing races of their antipodes. Dr. Lambert's paper is published at length in the Bulletin of the Academy.

2. *Arbeiten aus dem zoologische-zootomischen Institut im Würtzburg.* 8vo. Herausgegeben von Prof. Dr. CARL SEMPER.—

The third volume contains the following elaborate papers: The Uranogenital system of the Amphibia, by Dr. J. W. SPRENGEL, 114 pages, with 3 folded plates; Strobilation and Segmentation in articulate animals, with special reference to the homologies between Vertebrates, Annelids, and Anthropods, by C. SEMPER, 290 pages, with 12 folded plates; Studies on the Turbellaria (on the Plathelminthids) by CHARLES SEDGWICK MINOT, of Boston, 62 pages, with 5 plates; on the saliva and cement glands of the Decapods, by Dr. M. BRAUN, 8 pages, with 1 plate; Remarks on the "Nephrofneusten" of v. Ihering, by C. SEMPER.

3. *On the Brain of Chimæra monstrosa*, by B. G. WILDER, Proc. Acad. Nat. Sci. Philad., May 29, 1877. 34 pp. 8vo, with a plate.

IV. ASTRONOMY.

1. *New Planets.*—In a letter to the editors Prof. Watson says: "The following are the places, from the observations provisionally reduced, of the two planets recently discovered by me.

Planet (174) discovered August 8th, magnitude 10·3.

Ann Arbor.	Mean Time.	(174)α.	(174)δ.	No. Comp.
	h m s	h s	° ′ ″	
1877, August 8,	10 50 0	21 22 39·10	−16 4 7·0	2
16,	13 48 1	21 13 57·94	15 46 6·0	5
17,	9 39 25	21 13 5·89	15 44 8·0	5
18,	10 40 5	21 12 0·29	15 41 34·8	5
20,	11 11 13	21 9 55·43	15 36 30·4	5
26,	9 56 30	21 4 9·13	15 19 58·1	5
30,	12 15 30	21 0 33·55	15 7 29·1	2
Sept. 1,	9 48 4	20 59 3·24	15 1 27·9	9
3,	8 53 48	20 57 34·90	14 54 53·6	5

Planet (175) discovered September 2d, magnitude 11·5.

Ann Arbor.	Mean Time.	(175)α.	(175)δ.	No. Comp.
	h m s		° ′ ″	
1877, Sept.	2, 11 2 58	23 10 4·80	+0 44 59·1	5
	2, 13 50 35	23 9 58·39	0 44 50·2	5
	3, 10 40 9	23 9 10·38	0 43 36·9	6
	4, 10 11 56	23 8 16·21	+0 42 11·3	5

Observatory, Ann Arbor, September 10, 1877.

2. *Time of Rotation of Saturn.*—Professor HALL discovered on the night of December 7th, a bright spot on the ball of Saturn. Notice was sent to various astronomers and the spot was observed at Poughkeepsie, Albany, Hartford, etc. The spot was followed, and its position measured at Washington until Jan. 2d, or through more than sixty revolutions. Assuming that the spot had no proper motion on the surface of Saturn, Professor Hall obtains for the time of one revolution on its axis

$$10^h\ 14^m\ 23^s{\cdot}8 \pm 2^s{\cdot}30.$$

The only earlier determination of this quantity was made by Sir Wm. Herschel in 1793–4 who found it to be $10^h\ 16^m\ 0^s{\cdot}4$, which he believed could not be in error as much as two minutes. By a curious mistake his time for the rotation of the ring, or $10^h\ 29^m\ 16^s{\cdot}8$, has been hitherto given in almost all treatises on astronomy as the time of rotation of the planet itself.

3. *The newly discovered satellites of Mars.*—The announcement of this remarkable discovery made by Prof. Hall was too late to appear in the body of the September number of the Journal, but was given upon the third page of the cover. It is of such exceptional importance that we give in full Admiral Rodgers' Report to the Secretary of the Navy, dated August 21st.

"Sir: the outer satellite of Mars was first observed by Professor Asaph Hall, U. S. N., on the night of the 11th of August, 1877. Cloudy weather prevented the certain recognition of its true character at that time. On August 16th it was again observed, and its motion was established by observations extending through an interval of two hours, during which the planet moved over thirty seconds of arc. The inner satellite was first observed on the night of August 17th, and was also discovered by Professor Hall. On Saturday, August 18th, the discoveries were telegraphed to Alvan Clark and sons, Cambridgeport, Mass., in order that if the weather should be cloudy at Washington, they might confirm the existence of the satellites with the 26-inch telescope of Mr. McCormick, which is in their hands. This discovery was confirmed by Professor Pickering and his assistants, at Cambridge, Mass., and by the Messrs. Clark, at Cambridgeport. On August 19th the discovery was communicated to the Smithsonian Institution, by which it was announced to the American and European observatories in the following dispatch:

Two satellites of Mars discovered by Hall, at Washington. First, elongation west, August 18, *eleven hours, Washington time. Distance eighty seconds. Period, thirty hours. Distance of second, fifty seconds.*

It will be seen hereafter that the statement of fifty seconds as the distance of the inner one was erroneous. The observations hitherto made are as follows:

The First Satellite.

	h m	°	h m	"		
1877, Aug. 11,	14 40,	p= 59·6 (2);	14 45,	s=70·57 (2)	Obs.,	Hall.
16,	11 42,	----------		s=77·6: (1)	"	Hall.
	13 7,	p= 71·9 (2)	----------	s=80·83 (4)	"	Hall.
	13 36,	----------		s=80·4 (1)	"	Hall.
17,	16 2,	p= 85·5 (2);	16 19,	s=63·24 (3)	"	Hall.
18,	10 28,	p=251·7 (3);	10 18,	s=82·93 (8)	"	Newcomb.
	10 57,	p=244·5 (1);	11 5,	s=81·6 (1)	"	Harkness.
	11 50,	p=246·6 (4);	11 57,	s=81·77 (4)	"	Hall.
	14 32,	p=232·1 (4);	14 39,	s=61·04 (4)	"	Hall.
19,	11 42,	p=283·2 (2);	11 49,	s=46·20 (4)	"	Hall.
	15 43,	p=255·4 (4);	15 52,	s=81·37 (6)	"	Hall.
20,	10 28,	p= 61·1 (3);	10 33,	s=76·07 (2)	"	Hall.
	11 57,	p= 52·1 (4);	12 7,	s=59·93 (4)	"	Hall.

The Second Satellite.

	h m	°	h m	"		
1877, Aug. 17,	16 6,	p= 73·0 (2);	16 21,	s=30·81 (4)	Obs.,	Hall.
18,	11 31,	p=248·8 (2);	11 37,	s=34·65 (4)	"	Hall.
19,	11 25,	p=226·8 (2);	11 30,	s=24·08 (2)	"	Hall.
20,	13 15,	p= 67·1 (1);	13 26,	s=31·95 (3)	"	Hall.
	13 56,	----------		s=27·02 (4)	"	Hall.
	14 22,	p= 70 (est.);	14 22,	s=19·16 (3)	"	Hall.
	16 19,	p=250 (est.);	16 19,	s=15·15 (7)	"	Hall.
	16 35,	----------		s=16·70 (7)	"	Hall.

From these observations Professor Newcomb has derived the following approximate circular elements of the orbits. The probable errors assigned are only very rough estimates.

The Outer Satellite.

Major semi-axis of apparent orbit seen at distance [9·5930]	82·″5 ± 0·″5
Minor semi-axis of apparent orbit seen at distance [9·5930]	27·″7 ± 2·″
Major semi-axis of orbit seen at distance unity	32·″3
Position angles of apsides of apparent orbit	70°, 250° ± 2°
Passage through the west apsis (p=250°), Aug. 19, 16·6h, W. m. t.	
Period of revolution	30h 14m ± 2m
Hourly motion in Areocentric longitude	11·°907
Inclination of true orbit to the ecliptic	25·°4 ± 2°
Longitude of ascending node	82·°8 ± 3°
Position of pole of orbit in celestial sphere	Long. 352·°8
	Lat. +64·6
	R.A. 316·1
	Decl. +53·8
These elements gave for the mass of Mars	$\frac{1}{3{,}090{,}000}$

The Inner Satellite.

Major semi-axis of apparent orbit at distance [9·5930]	33·″0 ± 1″
Period of revolution	7h 38·5m ± 0·5m
Hourly motion in Areocentric longitude	47·°11
Passage through the eastern apsis (p=70°), Aug. 20, 13·0h, W. m. t.	

4. *The American Ephemeris and Nautical Almanac for the year* 1880, has been issued, under the superintendence of Professor Coffin, by the Bureau of Navigation at Washington.

5. *Does the Motion of the inner satellite of Mars disprove the Nebular Hypothesis?* by Professor Daniel Kirkwood. (Letter to the Editors.)—From eight measurements of the position and distance of the inner satellite of Mars as taken by Professor Hall within three days from the date of his first observation, Professor Newcomb found the period to be seven hours and thirty-eight minutes. On the theory, therefore, of a circular orbit the satellite is within 3400 miles of the planet's surface. Professor Hall remarks that the diameters of the Martial satellites are extremely small, probably not more than 50 or 100 miles. It is interesting to observe that even with the larger limit the bodies are smaller in comparison with their primary than any other secondaries in the solar system. According to Proctor, Mars revolves on its axis in $24^h\ 37^m\ 22{\cdot}735^s$. The inner satellite, therefore, completes three orbital revolutions in less than a Martial day. How is this remarkable fact to be reconciled with the cosmogony of Laplace?

Although the period of no other satellite is less than that of the rotation of its primary, the case can hardly be regarded as wholly unique. The rings of Saturn are clouds of extremely minute secondary planetoids revolving about the primary in approximate accordance with Kepler's third law. The periods of those in the outermost ring, like that of the exterior satellite of Mars, are somewhat greater than the rotation period of the primary. Those near the outer edge of the interior bright ring revolve in the same time with Saturn, and those at the inner visible edge of the dusky

ring complete a revolution in about eight hours. "These rings of Saturn, like everything cosmical, must be gradually decaying, because in the course of their motion round the planet there must be continual impacts amongst the separate portions of the mass; and of two which impinge, one may be accelerated, but it will be accelerated at the expense of the other. The other falls out of the race, as it were, and is gradually drawn in towards the planet. The consequence is that, possibly not so much on account of the improvement of telescopes of late years, but perhaps simply in consequence of this gradual closing in of the whole system, a new ring of Saturn has been observed inside the two old ones,—what is called from its appearance the crape ring, which was narrow when first observed, but is gradually becoming broader. That is formed of the laggards, as it were, which have been thrown out of the race, and which are gradually falling in towards the planet's surface."*

The process by which, in the case of Saturn's rings, the period of revolution has become less than that of the planet's rotation is here clearly indicated. It is not impossible that a similar process may have been in operation during the forming period of the Martial system. Unless some such explanation as this can be given, the short period of the inner satellite will doubtless be regarded as a conclusive argument against the nebular hypothesis.

Bloomington, Indiana, August 27th, 1877.

V. Miscellaneous Scientific Intelligence.

1. *American Association for the Advancement of Science.*—The twenty-sixth meeting of the American Association opened at Nashville, on Wednesday, August 29th. Professor Newcomb, of Washington, was the President of the meeting. The local committee, consisting of Messrs. Lindsley, Lupton, Safford and others, citizens of Nashville, contributed greatly to the success of the meeting by the arrangements they had made for the reception and entertainment of the members, and for the convenience of the several sessions. The hospitality of the people was unbounded, and the provisions for excursions were of the most generous kind. The attendance was large, though not equal to that of some meetings, owing to the season of the year for a place so far south, and the distance (over a thousand miles) from the Atlantic sea-board.

Through the generosity of Mr. Samuel Watkins, of Nashville, and others of the local committee, there were sent to the association, for distribution among its members, 400 copies of a volume containing as follows: Second Annual report of the Board of Health, gotten out with special reference to this Association; report on the Topography of Nashville, by Major Wilbur F. Foster, illustrated with a map embracing an area of three miles; report on the Geology of Nashville, by Professor Safford, State Geologist; report on the Water-supply, with a careful analysis, by Professor

* Tate's Recent Advances in Phys. Sci., p. 259.

Lupton; report upon the Climate of Nashville, by Dr. A. C. Ford, of the Signal Service; interesting facts in Nashville's history, taken from the newspapers and other sources, by Anson Nelson, Secretary of the Tennessee Historical Society; report by the Health officer upon the Sanitary condition of Nashville; a complete index, by Dr. George Blackie. Dr. Lindsley, through whom the gift was made, said that it was intended as a memorial volume. The gift was received with a hearty vote of thanks.

The place appointed for the meeting in 1878 was St. Louis, and the time, the third Wednesday in August. Professor O. C. MARSH was elected President for the ensuing year; R. B. THURSTON, of Hoboken, New Jersey, Vice-President of Section A; A. R. GROTE, of Buffalo, Vice-President of Section B; and H. C. BOLTON, General Secretary.

The retiring President, Professor W. B. Rogers, was unable to be present at the meeting, and hence the occasion failed of a Presidential Address, which in this case was looked for with high expectations.

The evening session of Wednesday was occupied with a lecture, by Professor Newcomb, on the recent astronomical discoveries—that of the Satellites of Mars by Professor Asaph Hall, and that of oxygen in the atmosphere of the sun by Professor Henry Draper; remarks, by Professor James Hall, on the history of the Association, and the work it had done; a lecture, by Professor J. Lawrence Smith, on meteoric stones; and a paper, by Professor A. R. Grote, on an International Scientific Service.

Professor Marsh, the Vice-President of Section B, occupied Thursday evening with a discourse on the "Introduction and Succession of Vertebrate Life in America," which was rich in facts from his own hard work among the vertebrate fossils of the Rocky Mountain region and other parts of the continent, also from the extended observations of Leidy, Cope, and other investigators in the same field, and which set forth the succession of vertebrate life, and the bearing of the whole on its introduction, with a fulness, as regards mammals, before unequalled. Professor Marsh's paper will appear in the following number of this Journal. On Monday a very valuable discourse was delivered by Professor Daniel Wilson "on the races of America."

The number of important papers read in the several sections was small. The following is a list of those read or accepted for reading.

I. *Section of Mathematics, Astronomy and Physics.*

On a New Type of Steam Engine, theoretically capable of utilizing the full Mechanical Equivalent of Heat Energy; and on some points of Theory indicating its practicability, R. H. THURSTON.—On a new method of planning researches, and of representing to the Eye the Results of Combination of three or more Elements in all possible proportions, id.—The work of the U. S. Board appointed to test iron, steel and other metals, id.

On the proper motion of the Trifid Nebula, M. 20, G. C. 4355, etc., E. S. HOLDEN.

A new Quadruple Objective for Astronomical Telescopes, E. GUNDLACH.—A new Periscopic Eye-piece, id.

On the arbitrary coefficient A (²) in Laplace's expression for the semi-diurnal tide, J. G. BARNARD.

Mechanics of the flight of birds, A. C. CAMPBELL.

The Physics of the Mississippi river below the Red river, C. G. FORSHEY.—The Physics of the Gulf of Mexico, id.

On a Measurement of the wave-length of the Blue line of the Spectrum of Indium, T. C. MENDENHALL.—On the proposed modification in the Metric System in its Introduction into the United States, id.

Improvement in use of the Reflecting Goniometer, H. W. WILEY.

A novel Radiometer, Mr. JEFFREY.

The Monetary Question, E. B. ELLIOTT.—On Standard Time, id.

On the Relation of Organ to Function; or of Form in general to Mode of Energy Received and Exerted, R. L. KIRKPATRICK.

II. *Subsection of Chemistry and Mineralogy.*

A Steam blast for general use in laboratories, with illustrations of same, J. L. SMITH.—Use of a current of steam in boiling liquids with and without precipitates for use in the analytical laboratory, id.—Some remarks on Phosphorus in Iron, id. —A peculiar Silicide of Iron with remarks on artificial Silicides of the metal, id. —On the general methods adopted in the analyses of the American Columbates, id.—On an American tantalite, id.

The action of Dilute Acid upon Ferrous Sulphide made from Cast-iron, F. P. DUNNINGTON.—The Minerals of a Deposit of Antimony Ores in Sevier County, Arkansas, id.

Ethers of some Bile Acids, and specimens, A. SPRINGER.

On the use of Hyposulphite of Soda for the precipitation of Alumina, C. L. MEES.

The various methods of separating and determining Barium, Strontium and Calcium. Part I. Determination of Strontium, P. SCHWEITZER.—On some interesting deductions from the solubility of difficultly soluble substances, id.

Note on the Separation of Iron from Cobalt and Nickel, A. H. ELLIOTT.

On the manufacture of steel by the open hearth process, B. S. HEDRICK.

III. *Section of Geology and Natural History.*

Our Knowledge of the Cotton Worm, A. R. GROTE. —A new Lepidopterous Insect Injurious to Vegetation, id.

On Sex in Flowers, T. MEEHAN.

The Law of Repetition, Miss VIRGINIA K. BOWERS.

On the Respiration of Amia, B. G. WILDER.

Agamous reproduction among the Cynipidæ, H. F. BASSETT.

On the Origin of Structural Variation, E. D. COPE.—On the Classification of the Extinct Fishes of the Lower types, id.

On the Silurian Island of the Cincinnati uplift with reference to its part in Tennessee, J. M. SAFFORD.—Notice of a specimen of Cyrtodonta ventricosa from the Lower Silurian, id.

On the Geographical and Geological Distribution of the genus Beatricea, and of certain other Fossil Corals in the Rocks of the Cincinnati Group, N. S. SHALER. —On the Original Connection of the Eastern and Western Coal-fields of the Ohio Valley, id.—On the continuation of the folds of the Alleghany Chain to the North of the Delaware River, id.—On the Recent Formation of a small Anticlinal Axis in Lincoln County, Kentucky, id.

New specimens from the Water Lime Group at Buffalo, A. R. GROTE and W. H. PITT.

On Geodes, S. J. WALLACE.

On the Annual Deposits of the Missouri River during the Post-Pliocene, J. E. TODD.

The Structure of Eruptive Mountains, J. W. POWELL.—Overplacement, id.

The Variation of certain Fresh Water Mollusks of the United States and their Geographical Distribution, A. G. WETHERBY.

Notes on the Silurian waters of Washoe, Nevada, T. STERRY HUNT.—Notes on the Geology of the Rocky Mountains, id.

Geology and Topography of the Oil Region of Tennessee and the Oil Springs and Wells, J. B. KILLEBREW.

Geology of the Region on the Headwaters of the Androscoggin River, J. H. HUNTINGTON.

A section of McKinny Hill, Tennessee, E. L. DRAKE.

Geological position and mode of origin of Hydrated brown oxide of Iron, E. T. COX.

On the Fibre of Gossipeum herbaceum (cotton plant) considered with reference to a practical application of its manufacture, J. A. RIDLEY.

On the use to be made of the Post Route Maps in the advancement of Science, B. S. HEDRICK.

Atmospheric Concussion as a Means of Disinfection, Mrs. H. R. INGRAM.

IV. *Subsection of Anthropology.*

On the Origin of the Japanese, S. ISAWA.

The former and present numbers of our Indians, G. MALLERY.

Additional Facts concerning Artificial Perforation of the Cranium in Ancient Mounds in Michigan, H. GILMAN.

Habits of the Moqui Tribe, E. A. BARBER.

Some Popular Errors concerning the North American Indians, J. W. POWELL.—Introduction to the Study of Indian Language, id.

On the ancient excavations in Western North Carolina, A. A. JULIEN.

Report on the Exploration of the Graves of the Mound Builders in Scott and Mississippi Counties, Missouri, H. N. RUST.

Observations on the skull of the Comanche, T. O. SUMMERS, Jr.

2. *Distant Points visible from Mt. Washington;* by W. H. PICKERING. (Read October 11, 1876). If an observer were to go up four particular peaks in the White Mountains, he could see all the distant points visible from any of the other summits, together with a good many more not visible from them. These four peaks are Washington, Moosilauke, Passaconnaway and Lafayette. I name them in the order of the extent of the distant views obtained from them alone. Now looking at the subject the other way, no matter from what distant point the White Mountains are seen, one of these four peaks must always be the most conspicuous object in the view, provided no near hills intervene. By means of the following formulæ the distance visible from any mountain may be readily calculated, and also the elevation a mountain must have in order to see a certain distance: $d = \frac{1}{10}\sqrt{175h}$, $h = \frac{4}{7}d^2$, where $d =$ distance in miles, and $h =$ elevation in feet. They may also be used to calculate mountain profiles as seen from distant points.

The following is a list of some of the more interesting distant points to be seen from Mt. Washington, many of them being visible only on rare occasions.

Mt. Belœil, Canada: distance 135 miles, position north 45° west, and nearly over Prospect Hill, Lancaster. It is quite a high mountain near Montreal, and is said to be visible. Lake Memphremagog, north border of Vermont: distance 70 miles, position north 40° west, and over Jefferson Hill. It requires a very clear day, as distant water is difficult to distinguish.

Mt. Carmel, Maine: distance 65 miles, position north 10° east, and just over Mt. Adams. It is very near the northern border of Maine, and is readily recognized by the steep slope on the eastern side. It is said that a very fine view may be obtained from it. Mt. Bigelow: distance 70 miles, position north 35° east, and nearly

over Mt. Hayes. It appears as three rounded hills. Just to the south of it and far beyond is a mountain with a very sharp apex, which is sometimes called Katahdin, but this is a mistake. Mt. Abraham: distance 65 miles, position north 40° east, and somewhat to the right of Mt. Hayes. A long serrated ridge, also sometimes called Katahdin. Mt. Katahdin, Maine: distance 163 miles, position north 45° east, and about half way between Mt. Hayes and Mt. Moriah. It is said to appear rising over a nearer saddle-shaped mountain, and to be recognized by its sharp peak—the sharpest in all the view from Washington. If visible at all in summer, it would be far the faintest object in sight in that direction. Mt. Blue, Maine: distance 57 miles, position north 57° east, and half way between Surprise and Moriah. It is quite a conspicuous pyramidal peak, and is near Farmington, Maine. It is used as a Coast Survey Station.

Portland, Maine: distance 65 miles, position south 51° east, and over the northern summit of Doublehead. It appears as a low white hill, with a long light blue line beyond it. With a telescope the hill resolves itself into a mass of closely packed white houses, and the blue line is seen to be thickly studded with sails. The Ocean, however, is not as often seen as some more distant objects in other directions, partly on account of the difficulty of distinguishing distant water, and partly because the atmosphere in this direction seems generally to be somewhat thicker than elsewhere. Lake Sebago, Maine: distance 43 miles, position south 48° east, and over Mt. Gemini. It is 14 miles long, and about 11 wide. Mt. Agamenticus, Maine: distance 80 miles, position south 24° east. A flat rounded hill of considerable height in the southern part of Maine, and forms a conspicuous landmark for sailors. Isles of Shoals, coast of New Hampshire: distance 97 miles, position south 22° east. They are very difficult to see, and are situated on the horizon just to the right of Agamenticus. Mt. Uncanoonuc, New Hampshire: distance 92 miles, position south 9° west, and half way between Mts. Crawford and Passaconnaway. Twin summits near Manchester. Mt. Wachusett, Massachusetts; distance 126·5 miles, position south 13° west, and just to the right of Whiteface, if it is visible. Mt. Monadnock, New Hampshire: distance 104·5 miles, position south 22° west, and a little to the right of Sandwich Dome. A very regular rounded summit. Mt. Kearsarge, New Hampshire: distance 70 miles, position south 24° west, and half way between Sandwich Dome and Carrigain.

Mt. Graylock, western Massachusetts: distance 147 miles, position south 40° west, and just over the summit of Mt. Webster. It has a pointed summit and is situated in the northwest corner of Massachusetts, near the Hoosac Tunnel, and is the highest mountain in the State, being 3,505 feet high, or about the same as Chocorua. It is extremely difficult to see, as it is, next to Katahdin, the most distant point visible. The Guide Book says it is 160 miles distant; this, however, is an error.

Mt. Ascutney, Vermont: distance 85 miles, position south 45° west. Situated in Windsor, Vermont, close to the Connecticut

River. Killington Peaks, Green Mountains: distance 91 miles, position south 59° west, and between Mts. Liberty and Blue. Twin peaked summits near Rutland, Vermont. Camel's Hump, Green Mountains: distance 80 miles, position north 87° west, and just over Bethlehem Street. It is a striking looking mountain, shaped like a truncated cone, with very steep sides. Readily visible at sunset on a clear day. Mt. Whiteface, Adirondack Mountains: distance 130 miles, position north 86° west. It is just barely visible, hardly rising above the right hand slope of Camel's Hump. This is one of the highest of the Adirondacks, rising to a height of 4,900 feet. Two lower peaks are seen just to the right, and three more some distance to the left. These however have not yet been identified, but if Mt. Marcy and any of the other higher summits are visible, they should appear about 7° to the south of Whiteface and nearly over the Fabyan House. Mt. Mansfield, Green Mountains: distance 78 miles, position north 78° west, and between the twin Mountain House and Mt. Deception. It is the highest of the Green Mountains, being 4,300 feet high, and appears as a long ridge bearing a fancied resemblance to a human face.—*Appalachia*, No. 2, March, 1877.

3. *Caution to Archæologists.*—The Archæological Section of the Academy of Sciences of St. Louis has issued a circular dated St. Louis, Mo., June 12, 1877, calling the attention of all lovers of science to the following statement of facts:—

"It is well known to all Archæologists that the Mississippi Valley contains a greater number of pre-historic remains than any other portion of the United States. It is the object of this Section to preserve these relics from destruction, and to keep such a record of their discovery and exhumation, as may render them available for scientific purposes. They find this work very much impeded by the operations of persons, who, under the direction of unprincipled traders, in this and other cities, are destroying in every direction the most interesting earthworks and other remains of the ancient races, with the sole object of making money by the sale of such articles as may be found therein.

Attention is also called to the fact, that imitations of the pottery from the Missouri Mounds are also being manufactured, and offered for sale as genuine antiquities. All who purchase collections from dealers thus obtain specimens that may be worthless; or, at best, have a greatly depreciated value, from the absence of the scientific data connected with their discovery.

To remedy this evil as far as possible, the Section has employed properly qualified persons to conduct explorations under their especial direction, and is willing to furnish to scientific bodies, or individuals interested in Archæology, specimens from the duplicates of its collection, either in exchange for articles from other localities, or by sale at a price sufficient only to cover the cost of procuring them. It is hoped that all who are desirous of promoting the interests of scientific enquiry, will aid the Section in its efforts, by refusing to purchase, or in any way countenance the mercenary traffic in antiquities."

The Secretary of the Society is Mr. F. F. Hilder, 604 North Fourth Street, St. Louis.

4. WILSON: *Handbook of Hygiene and Sanitary Science.* 3d edition, enlarged and re-written. 490 pp. 12mo. Philadelphia, 1877. (Lindsay and Blakiston.)—Dr. Wilson's well-known work is now placed, in its original English dress, before American readers. This is a clear, concise and sufficiently full description of the entire range of Sanitary Science, by a man of large experience as a health officer in the public service in Great Britain. The author has no pet theories to sustain and consequently is able to give to all matters falling under his review a fair consideration, while constant reference is made to authorities for fuller data than the limits of his work could admit. The subjects are treated in a systematic manner and the style makes agreeable reading of even the most technical portions. B. S.

5. *British Association.*—The meeting of the British Association for 1877, opened at Plymouth, on Wednesday, the 15th of August, and the address of the President, Professor Allen Thomson, was delivered on the evening of that day. The address of F. Galton before the section of Anthropology, and that of Mr. Pengelly before that of Geology, are republished on the preceding pages of this volume, from *Nature* of August 16 and 23. Sir William Thomson presented a paper advocating the doctrine suggested briefly in his Presidential address of 1875, that a meteorite might become the vehicle of animal life to this earth from another planet or heavenly body, and "was evidently listened to with much enjoyment." Much amusement was caused by his saying that "though the outside shell of a meteoric stone might be incandescent from the friction caused by its flight through the terrestrial atmosphere, yet within a crevice of that stone might be concealed a Colorado beetle, which, falling on the earth, might become the father of a large and prosperous family." A disbeliever in the doctrine, Professor Haughton, followed with objections, but said "that still he didn't care how many papa beetles came, so long as the mamma beetles were left at home." Among the more valuable papers were the following: on the rate of progression of groups of waves, and the rate at which energy is transmitted by waves, by Osborne Reynolds; on the effect of transverse stress on the magnetic susceptibility of iron, by Sir Wm. Thomson; unit of light for photometry, by A. Vernon Harcourt; on gallium, by Prof. Odling; a new method for studying the optical characters of minerals, by H. C. Sorby; result of tidal observations in the recent Arctic Expedition, by Prof. Haughton; also, by the same, on the best possible number of limbs for an animal; on the results of the North German Exploring Expedition in the west of Siberia, by Dr. Otto Finsch; on the Physical properties of solids and liquids in connection with the Earth's structure, by Professor Hennessy.

It was decided that the fiftieth or jubilee meeting of the Association—in 1881—be held in York, in consideration of the fact that its first meeting—that of 1831—was at that place.

6. *New Constructions in Graphical Statics;* by H. T. EDDY. Van Nostrand, New York: 1877. 8vo, pp. 62 and 9 folding plates. —This work is an application of the methods of Graphical Statics to the arch rib with and without joints, the suspension cable, the continuous girder, the retaining wall, the dome, etc.

The following publications of the U. S. Geological Survey of the Territories, F. V. Hayden in charge, have been received and will be noticed in another number; also other volumes whose titles follow:

Ninth Annual Report, embracing Colorado and parts of adjacent Territories, being a report of progress of the exploration for the year 1875, by F. V. Hayden. 827 pp. 8vo. Washington, 1877.

Report of the United States Geological Survey of the Territories, volume XI. Monographs of North American Rodentia, by Elliott Coues, Secretary and Naturalist of the Survey, and Joel Asaph Allen, Special Collaborator of the Survey. 1091 pp. 4to.

Miscellaneous Publications.—No. 7. Ethnography and Philology of the Hidatsa Indians, by Washington Matthews, Assistant Surgeon U. S. A. 239 pp. 8vo. —No. 8. Fur-bearing Animals: A Monograph of North American Mustelidæ, by Elliott Coues, Captain and Assistant Surgeon U. S. A. 348 pp. 8vo, with twenty plates.

Bulletin of the U. S. Geological and Geographical Survey of the Territories. Volume III, Number 4, August 5th, 1877.

Bulletin of the U. S. National Museum; No. 8.—Index to the names which have been applied to the subdivisions of the class Brachiopoda, by W. H. Dall. 88 pp. 8vo. Washington, 1877.

China: Ergebnisse eigener Reisen und darauf gegründeter Studien von Ferdinand Freiherrn von Richthofen; Band I, 758 pp. 4to, Berlin (New York, L. W. Schmidt).

Mesmerism, Spiritualism, etc. Historically and scientifically considered; being two Lectures delivered at the London Institution, by William B. Carpenter, C.B., etc. 158 pp. 8vo. New York, 1877. (D. Appleton & Co.)

Proceedings of the Davenport Academy of Natural Sciences, Volume I, Part I; January, 1876—June, 1877. Davenport, Iowa.

Jahres-Bericht des Naturhistorischen Vereins von Wisconsin für das Jahr 1876–77. Milwaukee.

The Western Review of Science and Industry, by Theodore S. Case. A monthly of 64 pages, published at Kansas City, Missouri, popular in its character.

Proceedings of the American Association for the Advancement of Science. Twenty-fifth meeting, held at Buffalo, N. Y., August, 1876. 368 pp. 8vo. 1877.

OBITUARY.

Professor HENRY NEWTON, E.M., Ph.D., Professor elect of Mining Engineering and Metallurgy of the Agricultural and Mechanical College of Ohio, at Columbus, died at Deadwood, Dak., on August 5th, in the 32d year of his age. Professor Newton was engaged in a geological examination of the Black Hills, which, begun two years ago, as Assistant Geologist to the United States Black Hills Expedition of the Interior Department. He was endeavoring to bring to completion this season, under the auspices of that branch of the geological explorations of the territories, in charge of Major Powell. Meanwhile Professor Newton, with great assiduity, had prepared a full report of his geological study of that region, with plates of fossils, and numerous drawings of sections and other important illustrations. The publication of this valuable report by the department, as it has more than once happened before with other reports of the same kind, had been grievously delayed—much to the annoyance and disappointment of its

young and enthusiastic author, whose health became impaired under such an additional strain upon his nervous system, immediately after very close confinement to office-work. Uninitiated in the ways of the departments at Washington, Professor Newton found no means to proceed to the publication of his report for many months after its date—of the disadvantage of which circumstance he was no less conscious, than apprehensive of the likelihood of having devoted two years of solid work to no purpose. Its publication was provided for last spring, as a part of the series of reports of geological explorations of the territories in charge of Major Powell. With the object of bringing his work down to date, and of revising it by the light of recent industrial developments, Professor Newton returned this season to the Black Hills, where he was fatally stricken with mountain fever, while prosecuting his work.

Professor Newton was for a number of years attached to the School of Mines of Columbia College, where he received his degrees and was Assistant in Geology. During the same period he did excellent service upon the Geological Survey of Ohio. J. P. K.

Moses Strong, Assistant Geologist in the Geological Survey of Wisconsin, died on the 18th of last August. Mr. Strong was engaged in a geological examination of the branches of the Chippewa River, and was endeavoring to pass in a skiff some rapids on the Flambeau branch, when the boat was upset, and he was drowned in an attempt to save a young companion who was unable to swim. Earlier in the season, he had explored a large tract occupied by the copper-bearing formation in the region of the Upper St. Croix River, and had examined the Huronian formation of Barron County, and just before his last excursion in behalf of the Geological Survey, he had revised the proof of his contribution to the forthcoming Report of the Geological Survey on his results of the year past. He had also completed and revised the proofs of his report on the Lead region, "which is accompanied by a series of topographical and geological maps that have commanded the unqualified admiration of all who have seen them." Professor T. C. Chamberlain, the director of the survey, states further, that "as a co-laborer in the scientific investigation of the structure of the State, he enjoyed the unhesitating confidence and admiration of his associates. In character he was modest and unassuming, and commanded respect rather by the merits he could not conceal than by any that were assumed. To attractive personal traits he added an integrity that was absolutely above question and a candor and honesty of expression that was eminent."

Mr. Strong, after graduation at Yale College, with the class of 1867, pursued scientific studies at a German University, and had thus thoroughly fitted himself for the work in which he was engaged. He leaves a young wife and children.

Professor Adolf Erman, an eminent German physicist, Professor in the Berlin University, died on the 13th of July, at the age of seventy-one.